POWER

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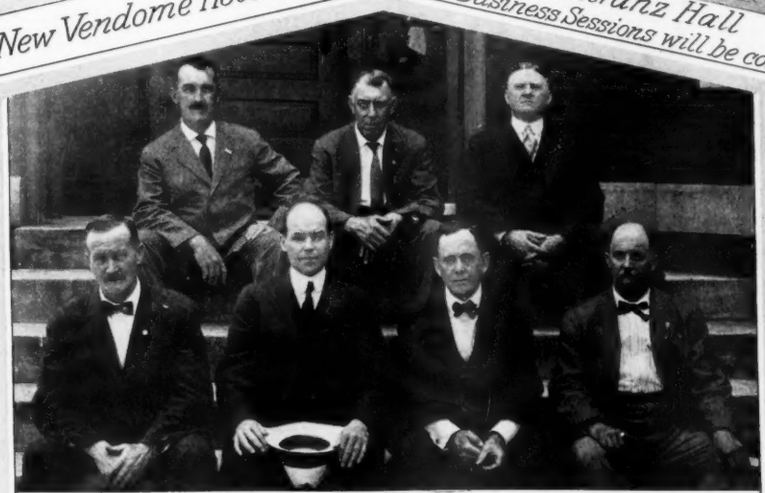
N·A·S·E· CONVENTION VIEWS

New Vendome Hotel

Liederkranz Hall where Business Sessions will be conducted



Convention Committee

Top Row, Left to Right: Charles Streithof, E. G. Heeger, Chairman, & G. C. Bruner. Bottom Row, Left to Right: Louis Minke, Henry Kollker, Gus Weber and Henry Kramer, (Wm. Lohoff absent)

Bosse Field Stadium

Memorial Coliseum where Exhibit will be held

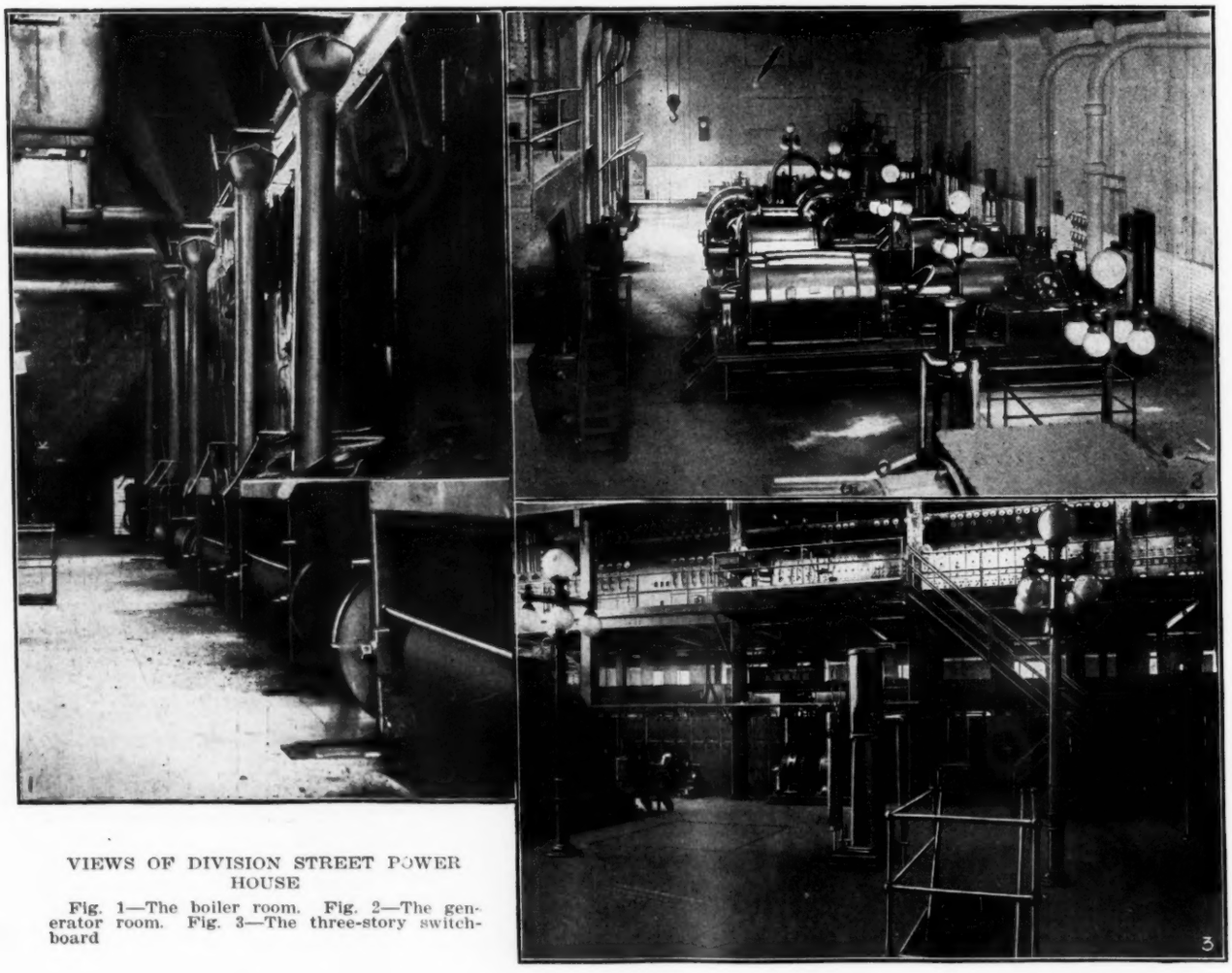
Leading Plants in Evansville

BY THOMAS WILSON

A brief description of a few of the largest power plants in the city that the visiting engineer may like to see, including the Public Utilities Co.'s power station, the water-works, two brewery plants and a flour-mill installation.

EVANSVILLE, Ind., with a population close to 100,000, has over 400 manufacturing plants turning out products valued at more than $35,000,000 per year. The city is the largest winter-wheat milling center in the country, ranks second in the production of furniture and hardwood lumber and is reported to have the largest individual buggy, furniture and independent cigar factories in the United States. Beer, plows, steam shovels, gasoline engines, pottery, wagons, stoves and iron store fronts are other products turned out in large quantities. Serving these various factories are more than 300 power plants, many of them small, ranging in size from 50 hp. up. Some of the larger power plants in the city, plants that would interest the visiting engineer, are briefly described in the following.

Division Street power station of the Public Utilities Co. is by far the largest generating plant in Evansville. It supplies electrical energy for the street railways, interurban lines, city lighting and commercial light and power. The station capacity is 10,250 kw., and the load runs as high as 7500 kw. Current is generated at 4000 volts three-phase with the neutral grounded. For the feeders to the interurban rotary-converter substations, the voltage is stepped up to 13,000 and 22,000 volts. The street railways are supplied through motor-generator sets in the power plant. The station contains five generating units. The first machines installed were two Curtis vertical turbines rated at 750 and 1000 kw. respectively, then a 1500-kw. Allis-Chalmers turbine and finally two Westinghouse double-flow turbo-generators, one of 2000 and the other of 5000 kw. capacity.



VIEWS OF DIVISION STREET POWER HOUSE

Fig. 1—The boiler room. Fig. 2—The generator room. Fig. 3—The three-story switchboard

The smallest vertical turbine is served by a jet condenser, the other units being equipped with surface condensers. With the exception of the vacuum pumps the auxiliaries are motor-driven, plenty of exhaust steam for the feed-water having been available from fourteen 12 x 36-in. deep-well pumps supplying circulating water for the condensers. Exhaust is also obtained from

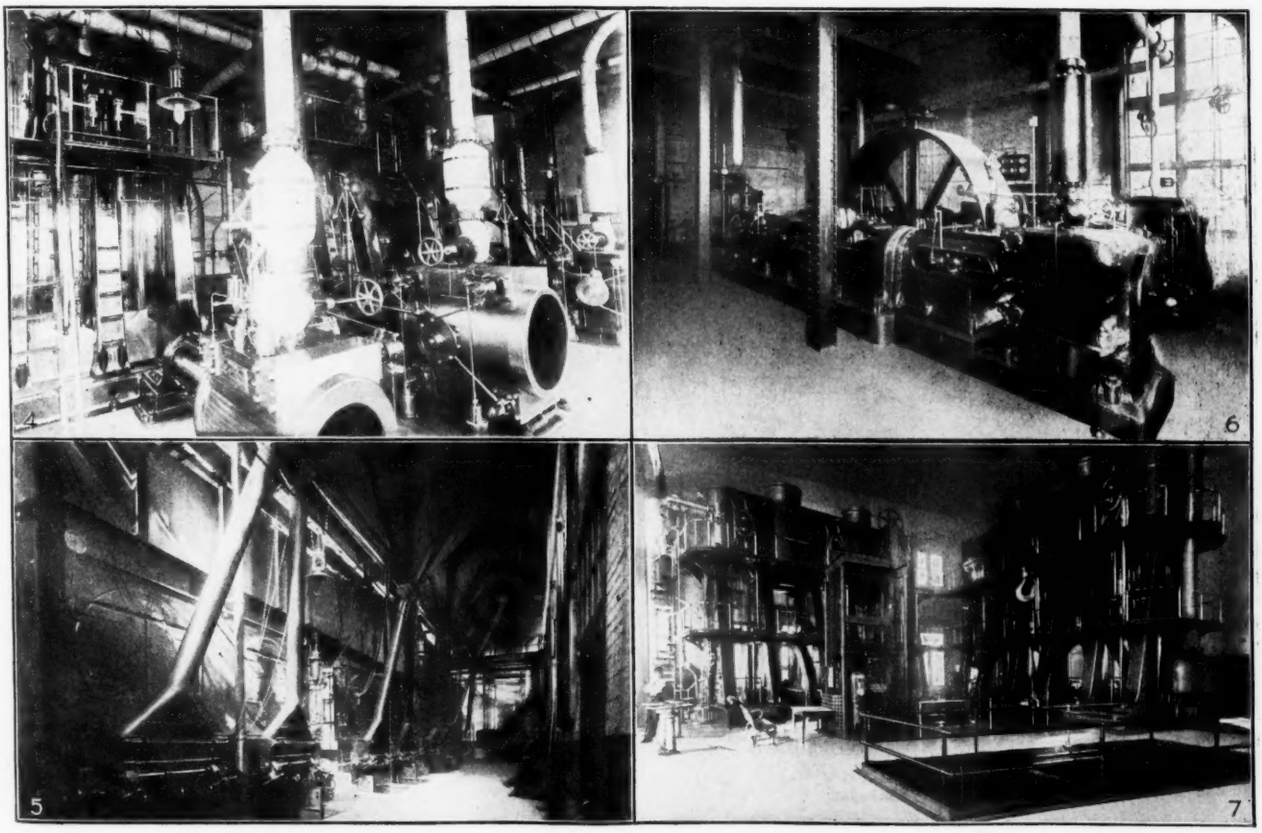
the vacuum pumps, two of four exciter sets serving the station and the boiler-feed pumps. The supply of cooling water has been conserved by the use of cooling towers. Owing to excessive corrosion caused by the well water, it was decided to run a 36-in. line to the river and pump a sufficient supply to the plant for condenser cooling, boiler makeup water, as before, to be taken from the city mains.

In a well at the river, 32 ft. diameter by 60 ft. deep, two 16-in. centrifugal pumps, each having a capacity of 7500 gal. per min., were installed. The pumps are driven by 150-hp. motors controlled from the power plant. From the river to the well there are two 36-in. intakes, each equipped with two 32-in. Liberty strainers. the duplication allowing one to be cleaned while the other is in operation.

In the boiler room there are eight water-tube boilers having an aggregate capacity of 3660 hp., made up of four 515-hp. B. & W., two 450-hp. and two 350-hp. Aultman & Taylor boilers. Eventually there will be six more boilers of 515-hp. capacity each. All are served by B. & W. chain grates, and natural draft is supplied by two concrete stacks, one rising 215 ft. and the other 200 ft. above the grates. All boilers have three gas passes formed by vertical baffles, operate at 210 lb. pressure and 100 deg. of superheat and are equipped with G. E. flow meters, Mason damper regulators and Bristol thermometers recording the temperature of the flue gases.

From bottom-dump railway cars coal for the plant is discharged into concrete track hoppers provided with gates through which the coal passes into industrial cars. These cars are elevated 51 ft. by a hydraulic elevator having a 12-in. ram and are pushed out over and dumped into individual 20-ton steel bunkers serving the boilers. Underneath, each boiler has fine-coal, ash and soot hoppers, the last-named being under the rear combustion chamber. All are served by the industrial cars. The ashes and soot are elevated into a large steel bunker discharging into railway cars or into wagons. The fine coal is returned to the bunkers.

Of special interest in the plant is a new switchboard, one of the Westinghouse Co.'s latest productions, equipped with a full complement of the most modern instruments and operating devices. The board and all apparatus take up three floors and the basement. There are two main busses that may be operated in parallel or separately, and three sets of auxiliary busses. If desired, it would be possible to run each generating unit separately, and one of the auxiliary busses could be cut in for either service or all three could be thrown together and relieve the main busses entirely. It is the custom to inspect all oil switches every three months, and at this time or in case of trouble it is an easy matter to transfer the circuit to one of the auxiliary busses and "cut out" the switch on which it is desired to work. It is thus evident that almost any combination is possible and that the board is unusually flexible. It is electrically controlled throughout. In each circuit there are four independent oil switches—one in each phase and one in neutral. Each switch is in an individual concrete compartment sealed by an asbestos door that is easily removable. The switches are sole-



PLANTS THAT WILL INTEREST THE CONVENTIONERS AT EVANSVILLE, IND.

Fig. 4—Ammonia compressors in the Cook brewery. Fig. 5—The Cook boiler room. Fig. 6—Horizontal ammonia compressor at Evansville brewery. Fig. 7—The water-works pumping engines

noid operated, with remote control from the board on the first balcony. The field rheostats are electrically controlled, the power circuits are equipped with automatic regulators and time-element overload relays of the latest type protect the generators. All city current is sent out of the station at 4000 volts.

During the convention the plant will be open for inspection and all visitors will be given a cordial welcome by G. E. Sloats, chief engineer.

Near to the central station just described is the large brewery of the F. W. Cook Brewing Co., the home of "Goldblume." Its capacity is 500,000 bbl. per day, and the output has reached 375,000 bbl. The equipment throughout is thoroughly modern, and all machines are motor-driven, there being in all 186 motors ranging from ¼ to 75 hp. in capacity.

It is the largest private plant in the city. The electric load averages about 2000 amp. at 110 volts, the current being supplied by two 250-kw. and one 200-kw. direct-current generators. The refrigerating plant consists of three De Lavergne vertical machines having an aggregate capacity of 800 tons. These compressors refrigerate the brewery and in addition have sufficient capacity to make 90 tons of ice per day in a distilled-water plant. The ammonia condensers are of the atmospheric type and are supplied with cooling water at 60 deg. F. from artesian wells.

In the boiler room are eight 225-hp. return-tubular Brownell boilers, 84 in. by 18 ft., served by Roney stokers. A Peck carrier handles the coal and ashes. The former is delivered to a railway track hopper, then passes through or around a crusher to an apron conveyor that transfers it to the carrier. Each battery of two boilers is served by a 150-ton steel bunker. The ashes are delivered by the carrier to an overhead bunker discharging to the railway cars bringing in the coal.

G. C. Bruner, chief engineer, is proud of his plant and may be counted upon to extend the courtesies of the brewery in the German Room, where "Goldblume" and other brands are on tap.

At the plant of the Evansville Brewery Association a cross-compound duplex 250-ton horizontal York compressor is of special interest. It is the largest horizontal machine in the state, covering a floor area 37 ft. long by 15 ft. wide, totaling 555 sq.ft., or 2.2 sq.ft. per ton of refrigerating capacity. The shipping weight of engine and compressor was 275,000 lb. The steam engine is 24 and 44 x 34-in. and the compressor cylinders are each 17½ in. diameter. The engine valve gear is operated by double eccentrics, and the governor permits a range of speed of from 30 to 70 r.p.m. A complete central oiling system and all modern safety appliances are provided. The engine is served by a barometric condenser.

Other equipment in the plant comprises two 75-ton vertical compressors, a 30-ton raw-water ice plant, two small generating sets and a boiler plant containing three hand-fired return-tubular boilers and one 400-hp. Stirling boiler equipped with a B. & W. chain-grate stoker. This brewery maintains within its walls a room known as the Rathskeller.

FIG. 8. RAPID FILTER PLANT SERVING THE WATER-WORKS AT EVANSVILLE

Those who attended the last convention at Evansville will remember the water-works, which at that time had two 10,000,000-gal. vertical high-duty pumping engines. A number of additions have since been made. A rapid filter plant, two low-lift centrifugal pumping units to

supply the river water to the filters and two high-lift centrifugal pumps to act as a reserve to the pumping engines in forcing the water into the city mains, will be recognized as new equipment. The filtration plant has twelve sand and gravel filters, each having a rated capacity of 1,000,000 gal. per 24 hours if run at the rate of 125,000,000 gal. per acre daily. Each concrete box-form filter is of 368 sq.ft. area and is 8 ft. deep.

Unlike other installations on the Ohio River, long-time storage is not available for the disposition of the coarse suspended particles before coagulation. Three settling basins having a total capacity of 2,500,000 gal. have been provided. Two give a two-hour detention period, and the third provides one-hour storage. There are three coagulating basins at the side of the two rows of filters and separated from the latter by a forebay controlling the distribution of water in and out of the basins. A clear well having a capacity of 1,900,000 gal. extends under the filters and headhouse.

In the center of the pumping station is a circular pump pit 62 ft. diameter and 61 ft. deep. On the floor of this pit are located the old pumps. Fourteen feet above the floor on an elevated foundation of reinforced concrete are the two low-lift 15,000,000-gal. De Laval pumping units, each consisting of a 225-hp. horizontal turbine driving in parallel two single-stage double-suction pumps. Reduction gearing permits a turbine speed of 10,000 r.p.m. and a pump speed of 900 r.p.m. These units operate under heads varying from 13 to 62 feet.

The high-lift units are installed outside of the pit at the basement-floor level. They are of the same type and capacity as the other centrifugal units, but in this case a unit consists of a turbine of 575-hp. rating driving two 20-in. centrifugal pumps connected in series to work against 70 lb. pressure. The two units may be operated in series or parallel. Upon starting the second pump, they are thrown automatically into series and are capable of operating against a head of 120 lb. for fire service. Either pump may be used to relieve the pumping engines or to help out during the heavy summer load.

Three 260-hp. and one 308-hp. Stirling boilers supply the steam for the plant. They are equipped with Roney stokers. Ashes are removed by a steam-jet vacuum system, and arrangements are being made to install overhead coal bunkers. Charles Streithof, superintendent of the water-works, will be glad to supply all information concerning the station or its operation.

The Akin-Erskine Mills

Among the interesting attractions of the city are the large flour mills of the Akin-Erskine Milling Co., which have capacity to turn out 2500 bbl. of flour per day. In the mill the machinery is modern throughout. The power plant contains one 300-hp. and one 600-hp. Murray Corliss engines connected to the mill by rope drives. There are 1050 hp. in six return-tubular boilers. Two of them are of Brownell make, rated at 225-hp. each, set in steel casings. The boilers are the first in the city for which this type of setting was employed.

Other interesting manufacturing plants are the Hercules Buggy Co., a large maker of gasoline engines, buggies and automobile bodies; the immense establishment of the Globe-Bosse-World Furniture Co.; the Bucyrus Co., where steam shovels are a leading product, and a host of other concerns.

Don'ts for the Turbine Operator

Certain practices should be avoided in the operation of a steam turbine. A few of them are set forth herewith in the form of "Don'ts" for the engineer who has had little or no experience in their operation.

Don't start a turbine, except in case of emergency, without warming it up. If a machine is likely to be called for suddenly, keep it warm.

Don't under any circumstances start a turbine without having the proper oil pressure on the bearings.

Don't fail to keep the oil clean and well filtered. If the bearings are found running warmer than usual, look after the oil. If it is right, look after the cooling coils, other conditions being normal.

Circulating Pump Should Be Running

Don't start a condensing turbine unless the water-circulating pump is running. To do so, with a surface condenser, invites the danger of buckling the tubes, with the possible result of pulling some of them out of the tube heads, thus putting the condenser out of service and creating an expensive repair bill.

Don't permit the rotor blading to rub as, if it is serious enough, it will strip the blading; therefore always maintain a safe clearance.

Don't fail to examine the blading when a machine is down, as this is the vital part of the machine. Check the clearances by taking liners out from the bottom of the bearing until there is a rub. These liners are on the side or bottom and top of the bearing and are in thousandths of an inch in thickness. When doing this work, uncouple the turbine spindle and turn it over by hand. It is then easy to detect a rub, whereupon counting the liners will give the clearance at the bottom. This can be done the same on the sides or the top if necessary, but a thickness gage will give the sides, and the top seldom gives trouble if once the machine has properly been set and lined up.

Don't fail to watch for corrosion of the condenser tubes. Corrosion will also affect the blading, and it is first discernible at the edges and at the base next to the spindle. It, however, comes on gradually and it takes time to finally destroy them.

Don't forget that if a turbine is operated in connection with boilers that are continually priming and foaming, the high-pressure blading will become filled and clogged up with the sediment carried over with the steam and that the power of the machine is affected. Both of the foregoing conditions are first indicated by power loss, which gradually increases as the trouble expands.

High Vacuum Important

Don't neglect the vacuum. Maintain a high, steady vacuum on the machine for economy and quiet operation. When a turbine suddenly loses its vacuum or the vacuum comes on, a vibrating is discernible. This is caused by a change in temperature within the machine.

Don't fail to look for air leaks if the vacuum fails gradually or it is difficult to get, the air pump and circulating water being all right. These may be found in the seal of the glands, equalizing pipes, expansion joints or some of the gaskets in the exhaust leaking

between the turbine and the condenser. A coat or two of asphaltum paint on the exhaust line will materially increase the vacuum by stopping small air leaks, which cannot be easily discovered. The higher the vacuum on a turbine the more efficiently it operates, and every additional fraction of an inch is a gain in the turbine efficiency.

Don't overlook the probability that if a turbine at light loads runs above speed, the main valve is probably leaking or, if it has a steam-actuated governor, that the spring has not enough tension to close the valve. Additional washers above the spring will remedy the trouble if it comes from the spring.

Don't neglect to calculate or obtain by other means the speed of the governor. This can be found by figuring the ratio of the governor speed to that of the shaft. A frequency meter is desirable and accurate and will tell at a glance when the speed is above or below normal. As all stations do not have such an instrument, it is desirable to frequently use a speed indicator on the governor shaft and keep it within the proper speed.

Don't think that thermometers should not be used at all times on the bearings and in the oil. These will give warning if conditions are not normal and may possibly prevent trouble. A bearing should not run at a temperature of more than 40 deg. F. above the temperature of the room.

Don't fail to see that the exhaust pipe is drained of water before starting the turbine, if a barometric condenser is used. When a jet condenser is used, should anything happen to the air pump, immediately close off the injection water and allow the turbine to exhaust to the atmosphere until the trouble is overcome.

Don't throw the load off or on a turbine too suddenly. This will put an unnecessary strain on the machine and, in case of throwing on a load, may draw water over into the turbine. This will put a contracting strain upon the blading, casing and spindle. After the water has cleared away, the incoming steam will set up an opposite strain on the same parts. Water is detrimental to the blading and often destroys some of it. Avoid all sudden changes of temperature in the machine.

Don't leave material in a turbine when a machine is opened up and work is being done on it. Care must be taken not to drop anything in or about the internal parts, which might be possibly overlooked when assembling it again. Avoid the use of waste in wiping about the machine when open, as it may get into the oiling system and clog it.

Voltage Control of Commutating-Pole Synchronous Converters

By J. L. BURNHAM
Designing Engineer, General Electric Co.

The different types of commutating-pole synchronous converters are discussed and the effect of the direct-connected booster upon the commutation of these machines. The operation of a special type of relay that has been developed to control the commutation of synchronous converters with direct-connected boosters is explained.

EVEN though the synchronous converter is subject to more possibilities for trouble in operation than the motor-generator set, it has become more largely used on account of its grea er efficiency and usually lower cost. The use of one winding in the converter armature, for both alternating and direct current, ties the machine electrically to both the alternating- and direct-current systems so that a disturbance on either system will directly affect the other. The converter also has less flexibility of voltage control from the fact that the same armature winding is used for both direct and alternating current. This has been the principal handicap to its more extensive use.

The ratio of the alternating- to the direct-current voltage is fixed so that it is necessary to provide means for changing the alternating-current voltage if changes in direct-current voltage are desirable. There are several methods for changing the alternating-current voltage in use at the present time. The most recent is the alternating-current booster connected mechanically to the converter and having the same number of poles, as shown in Figs. 1 and 2. The former methods of voltage control effected a change in the alternating-current voltage by apparatus separated from the converter and involved no new problems in converter performance. The direct-connected synchronous booster, however, on account of its action on the converter, makes necessary certain special features of control for the commutating-field excitation, which are to be described in detail later.

The purpose of commutating poles on direct-current machines is to assist in reversing the current in the armature coils short-circuited by the brushes as the coils pass from one circuit to another and thus avoid sparking.

Current reversal in an armature coil produces a voltage at its terminals—that is, across adjacent commutator bars—which is proportional to the reactance of the coil, amount of current and rate of reversal. This is commonly called the reactance voltage of commutation. The voltage generated by a coil passing through the commutating-pole field is opposed to the reactance voltage. The more completely these voltages correspond and cancel, the better the commutation. On account of the many variables in the magnetic circuits, there are limitations which do not permit complete cancellation of the reactance voltage. Therefore, designers of direct-current machinery must learn from experience what reactance voltage is allowable to obtain good commutation. When the current rating is given, it is necessary to use

the proper proportions of armature conductors, slots and teeth and rate of reversal to keep the reactance of the coil within certain limits, known from past performances of similar machines, which will not produce sparking.

These considerations apply equally to direct-current generators, synchronous converters and synchronous converters with alternating-current boosters. Require-

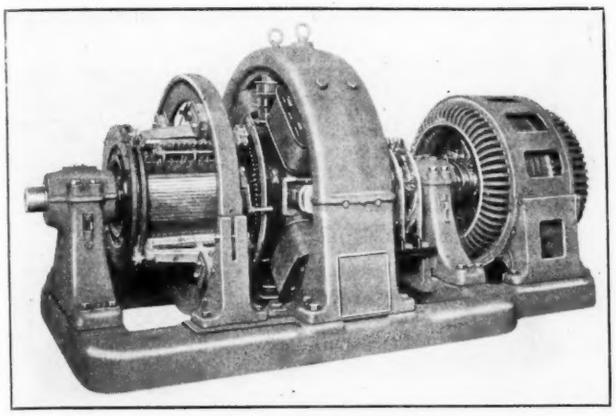


FIG. 1. REVOLVING-FIELD-BOOSTER TYPE SYNCHRONOUS CONVERTER

ments for strength of excitation of commutating-field windings, however, are different for each of the foregoing types of machines. The field strength produced by the result of excitation from all sources affecting the commutating pole is practically the same for all types of direct-current machines of equal commutating ability, but the factors entering into the excitation of the commutating poles are different. The principal exciting forces outside of the field winding that affect the

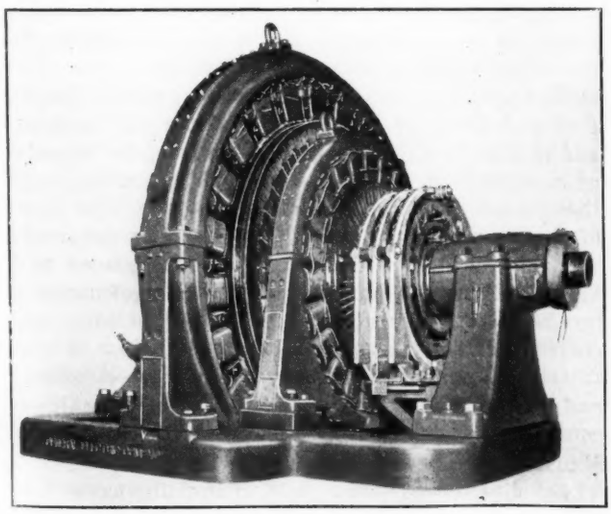


FIG. 2. REVOLVING-ARMATURE-BOOSTER TYPE SYNCHRONOUS CONVERTER

commutating-pole field strength that must be balanced by opposing excitation of the commutating pole are:

For direct-current generators or motors, an excitation equal and opposite to the armature reaction.

For synchronous converters an excitation equal and opposite to the difference of the armature reaction of the alternating-current input and direct-current output (about 15 per cent. of the direct-current armature reaction).

For a synchronous converter with a direct-connected alternating-current booster, the same as for the converter but with an additional excitation to offset the effect of the current in the converter armature which is required to drive the alternating-current booster or which is generated in the converter armature by the booster driving the converter. (Alternating-current boosters are required to both raise and lower the alternating-current voltage.)

For the generator and synchronous converter the commutating poles may be excited by a series winding, as the forces mentioned above, as well as the reactance voltage, are all proportional to load current. The synchronous converter with direct-connected booster, however, requires, in addition to the series winding, a shunt winding on the commutating poles to take care of the action of the booster upon the converter. When the

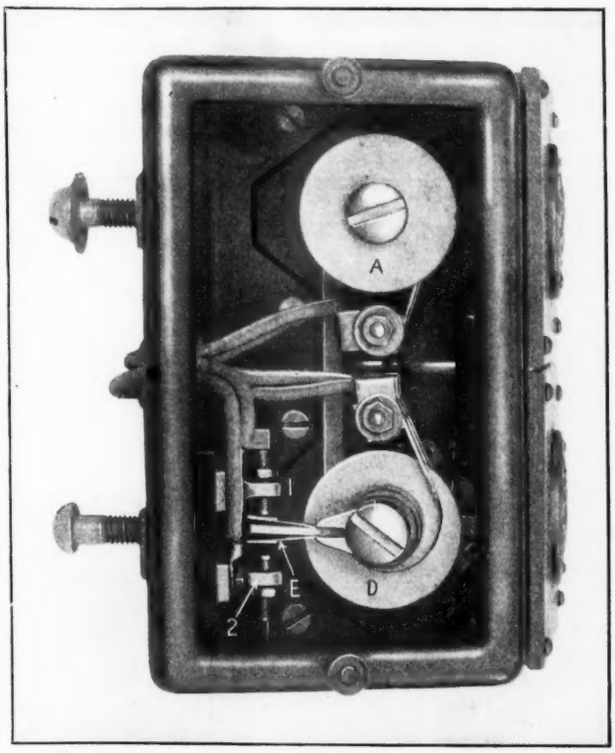


FIG. 3. COMMUTATION-CONTROL RELAY

direct-current voltage is being increased by exciting the booster to raise the alternating-current line voltage, the booster is acting as a generator requiring an additional motor current in the converter armature to drive it. The armature reaction of this additional motor current in the converter armature affects the commutating-pole strength and must be canceled by the excitation of the additional commutating-pole winding. This excitation, it will be seen, would be in opposition to that of the series winding.

Similarly, if the booster is used to lower the alternating-current line voltage, it acts as a motor driving the converter as a direct-current generator. This additional generator output from the converter will give an armature reaction which must be canceled by excitation of the additional winding the same as before but in reverse direction; that is, so it will add to the series excitation. Whether the booster is raising or

lowering the alternating-current line voltage, the excitation of the additional winding on the commutating field must be excited in proportion to the kilowatts of work being done by the booster. Several schemes to excite the additional field winding on the commutating poles automatically, to the required strength, have been proposed and used in service, but only one will be given consideration here.

The first methods used in this country gave only approximately correct adjustments of the shunt-commutating field strength in one or more steps for the entire range. Very good results were obtained with four steps, but as the speeds of converters were increased and more dependence placed on the commutating poles to secure good commutation, more steps in the control—that is, less departure from the correct excitation—was desirable. To meet this requirement a device to hold the shunt-commutating field more closely proportional to kilowatts on the booster was necessary. The contact-making relay shown in Fig. 3 was developed for this purpose. It controls a small motor *F*, which operates the reversing rheostat for the shunt-commutating field (Fig. 4). The diagram in Fig. 5 gives the connection

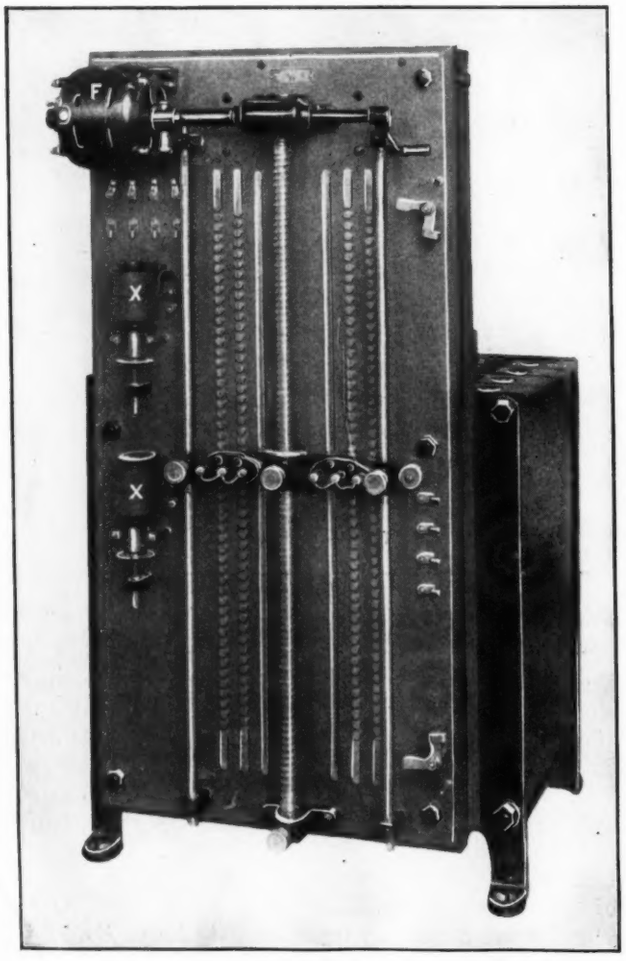


FIG. 4. COMMUTATING-FIELD RHEOSTAT

of the relay, rheostat, converter and booster. With the revolving-armature type of booster, Fig. 2, a small auxiliary collector ring to obtain the booster voltage is used, as shown in Fig. 5. This would not be necessary with the revolving-field type booster, Fig. 1.

The contact-making relay (commutation-control relay, Figs. 3 and 5) consists of two relay elements connected together mechanically so their torques may be balanced against each other. One element, Fig. 5, carries the shunt-commutating field current in one coil *C* and an approximately fixed excitation in the other coil *S*, so that its

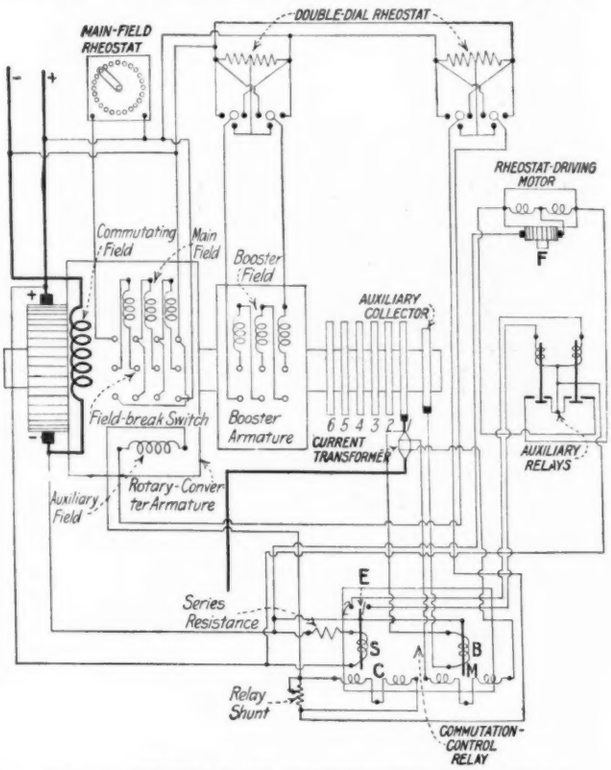


FIG. 5. DIAGRAM OF CONNECTIONS FOR RELAY, RHEOSTAT, BOOSTER AND CONVERTER

torque is proportional to the shunt-commutating-field excitation. The direct-current element is also shown at *D*, Fig. 3. The other element has applied to one coil, *B*, Fig. 5, the alternating-current voltage of the booster and to the other coil *M*, the current from the secondary of a series transformer, connected in the main line, so that its torque is proportional to the voltage and current of the booster; that is, to the kilowatts of the booster. This alternating-current element is also shown at *A*, Fig. 3. When the torques of these two elements are not balanced, their axes rotate through a small angle corresponding to the travel of an arm *E*, Figs. 3 and 5, fastened to the axis of the direct-current elements *D* and limited in rotation by two steps, 1 and 2, which are contact points in the control circuit. The moving arm *E* makes contact with one point or the other, depending on the direction of torque, and in so doing closes a circuit through one or the other of two auxiliary relays, Fig. 5, and also shown at *X*, Fig. 4, which determine the direction of rotation of the small driving motor *F*, controlling the rheostat in the shunt-commutating field. When the torques of the two elements of the relay are balanced, the movable arm *E* does not touch either stationary point, but if a change in the voltage or load occurs on the booster, the changed torque will move the contact arm to a position which will cause the motor *F* of the rheostat to operate in the proper direction to change the shunt-commutating field current (which also passes through the other element of the relay) to such

a value that it will restore the balance so the contact arm will move to mid-position again. It will be seen that this method of control will maintain the shunt-commutating-field strength to a correct value at all times within the limits of sensitiveness of the relay and a small change for each step in the rheostat.

The rheostat, Fig. 4, is of the reversing type, having two sets of contact buttons connected across the resistance in reverse order, the resistance being connected

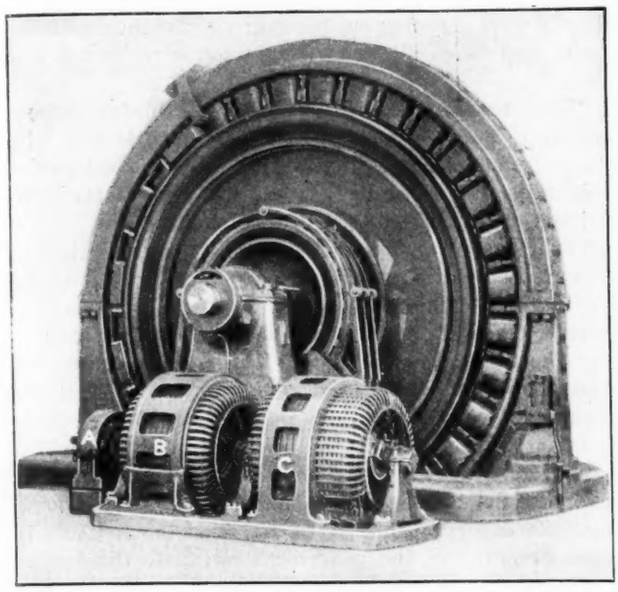


FIG. 6. SYNCHRONOUS CONVERTER WITH SEPARATE BOOSTER SET

across the source of excitation. It will be seen that the movement of the rheostat contacts from one end to the other will change the shunt-commutating field from full excitation in one direction down to zero and up to full excitation in the other direction. With this arrangement the booster will change the alternating-current voltage to the full-voltage range of the booster, thus the size of booster will be only one-half what it would have to be if utilized in one direction only for the same range in voltage.

The revolving-armature-booster type of synchronous converter, Fig. 2, is more frequently used, principally for manufacturing reasons. For the smaller machines, however, where ventilation is restricted and the distance between bearings comparatively large, it is a decided advantage to make use of a revolving-field-booster type, Fig. 1. In fact, there are some designs of machines that can use only this type. As previously mentioned, the revolving-armature booster requires an extra ring to obtain the booster voltage, for the scheme of control described. With the revolving-field booster, the alternating-current windings are stationary so that their voltage may be derived by stationary connections. To offset this advantage, the revolving-field booster requires collector rings for the current to excite the fields. The revolving-field type of booster has somewhat greater flexibility than the revolving armature for adjustments, and it may be readily detached from the converter and the converter used without the regulating feature if the booster fails and has to be repaired, or is not required.

The direct-connected boosters, Figs. 1 and 2, must have as many poles as the converter with which it is used. The cost is therefore greater for the larger machines than would obtain if a lesser number of poles with high speed could be chosen. For some larger installations it has been found that a synchronous booster direct-connected to a synchronous motor of the same number of poles, Fig. 6, and operating at a maximum economical speed is actually cheaper, including the driving motor, than a direct-connected booster. The machine shown in the figure is designed for 60 cycles and is rated at 5800 kw. at 500 to 580 volts. It is twice as large as any 60-cycle converter previously constructed. The separate booster set has the further advantage of making unnecessary the shunt-commutating field with its control equipment as the voltage control is external to the converter and has no influence on the commutation. On the booster set, Fig. 6, the small machine *A* is the exciter for the booster *B* and the synchronous motor *C*.

The machine shown in Fig. 7 has a rated output of 13,000 amp. at 525 volts (6825 kw.), but does not have any booster for voltage control. Some large installations have been made where the entire output of the generating station is used by the converters for one

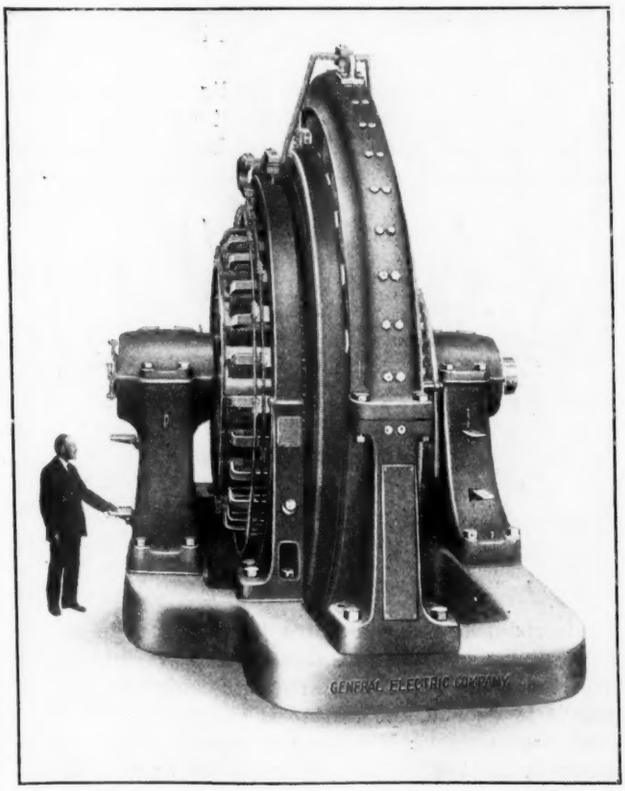


FIG. 7. SYNCHRONOUS CONVERTER WITHOUT BOOSTER

particular purpose which requires certain variations in direct-current voltage. In this case the required voltage variation is obtained by changing the generated voltage at the station. For such service the equipment is much simpler than when a variety of service is required from the same transmission. If a relatively small proportion of the load on such a system would require a fixed voltage, a booster converter could be employed to offset the variations in the alternating-current voltage.

Tom Hunter, Hoisting Engineer

BY WARREN O. ROGERS

We rest beside the railroad track, and Hunter, between smokes, tells of repair jobs he has seen. These consisted of methods employed in repairing stripped gear teeth, cracked compressor frames and engine cylinders. All were of such nature that they could be accomplished by any good mechanic.

AS WE made our way along the railroad track toward the Baltic mines, my mind reverted to the jokes that have been made regarding stranded actors pounding the ties, and they had my sympathy. The day was warm and finally, when about halfway between the Trimountain and Baltic mines, Hunter suggested that we hold down a fallen tree while we smoked a couple of coffin spikes.

"These three mines, the Champion, Trimountain and Baltic, produced, I understand, around 40,000,000 lb. of copper last year, which is the best in their history. In 1915 the average run of the three mines was 32½ lb. of copper per ton of rock, and I believe the rate was maintained during last year."

"That should bring in some profits with the present price of copper, unless accidents eat them up."

"Well, I suppose that a series of bad accidents would make the stockholder somewhat poorer, but a good mechanic about a mine can save a lot of money in a year by repairing broken apparatus instead of throwing it upon the scrap heap. When a well-equipped machine shop is to be had, the matter is simplified, but sometimes the mechanic is obliged to resort to the rough-and-ready method of doing a repair job because of the lack of suitable machines.

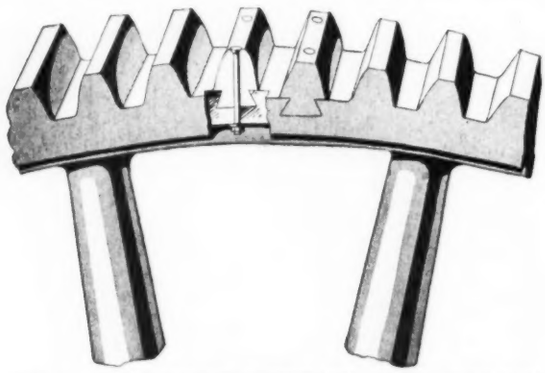


FIG. 1. GEAR TEETH DOVETAILED INTO THE RIM

"For instance, in the case of a geared hoist of the second-motion type, if a couple of teeth were to be broken out of the large gear, it would mean a loss of time and hoisting production while a new gear or section, if it were a sectional gear, was being sent from the builders. In one instance this very thing happened and the shaft was at a standstill until repairs could be made.

"But the man in charge of the job got after it on the jump and ordered the blacksmith to forge two steel blank teeth somewhere near the proper size and the shape of the regular gear teeth, but made with an extension at the base to make an anchor in the rim of the gear. The forged teeth were worked down to the proper size by chipping and filing, and the base was made into a dovetail. While this work was going on, other mechanics were chipping out the gear rim for the dovetailed teeth, and when all was ready they were driven into place."

"That sounds all right," I said, as Hunter stopped talking to hunt for a match, "but my idea is that with the extreme amount of vibration of a second-motion hoisting engine those teeth would work out of the dovetail and cause a bigger smash than the first one."

"That's right, go off at half cock!" grinned Hunter, as he successfully got his cigar going again for the ninth time. "The teeth didn't work out because they were bolted to the gear rim. I'll make a sketch to show how the whole shooting match looked when it was finished," and he drew Fig. 1. "Holes were drilled and countersunk at the top, and the bolt heads were made to fit in them and the nuts drew the bolts tight.

"You remember at the coal mines in Pennsylvania we saw more than one engineer plug his engine while hoisting. Reversing a hoist with full load on is likely to cause breaking of the gear teeth owing to the sudden change of load. In one case I knew of, where the work was comparatively light, the broken teeth were repaired by smoothing down the broken stub ends flush with the rim of the gear. Then holes were drilled and tapped across the rim where the broken teeth were, and steel studs, made with a square head, were screwed into the tapped holes. The heads were then cut off, after which the studs were shaped the same as the other teeth," and Hunter sketched Fig. 2.

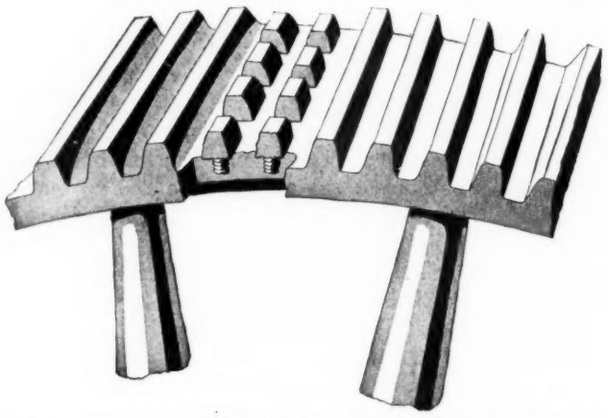


FIG. 2. STUDS SCREWED INTO GEAR RIM AND SHAPED AS TEETH

"I have seen similar stunts pulled off in the case of very small machine gears, where holes were drilled without tapping and steel pins of the proper length tightly driven in. When fitted to shape, the gear was almost as good as before the break."

"The man who first hit on those methods of repairing a gear earned his pay for one day at least," I said, watching a rock train rumble past to the stamp mill.

"Yes," answered Hunter, "and we will hope that his ability was rewarded with a fatter pay envelope.

"I remember another gear-tooth repair job. The gear was cast whole and was used working under a heavy load. The broken tooth was trimmed down flush with the rim and a square radial channel was cut on each side of the rim, like this," drawing Fig. 4. "The slot, in this case, was cut the same width as the tooth. A piece of wrought iron was slotted in the center to fit over the web of the gear, the projections fitting in the channels cut in the rim. Next, a countersunk hole was drilled lengthwise through the tooth and gear web, and a hot pin was driven in and riveted in place. This prevented the tooth from working loose as the contraction of the rivet drew the whole together."

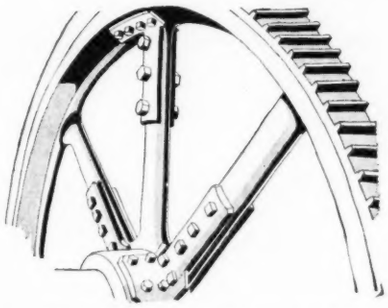


FIG. 3. CRACKED DRUM GEAR AS REPAIRED

Hunter at this point began fishing in his pockets for his pipe and, after he had loaded it, said:

"I remember a drum gear on a small steam hoist that was repaired and made to do service after it had been through quite a jolt—I never knew what. Three spokes were cracked, two at the hub and one at the rim of the drum. Some angle plates were made out of 1-in. thick iron. Those that came next to the hub were curved at the base to conform to the curvature of the hub, and the other arm of the angle was made about the width of the spoke and curved to shape for a tight fit. The iron that fitted to the rim was made in a similar way, but curved to fit the inside of the rim. This sketch," said Hunter, producing Fig. 3, "shows about what I mean. When the angle plates were fitted, they were drilled for bolts, and corresponding holes were drilled in the spokes and hub, those in the latter being tapped for capscrews, as were also those in the rim. In order to make as strong a job as possible, these angle irons were used in pairs, one on each side of each spoke. Six ¾-in. capscrews were used in the hub and three in the spokes. The job was working all right the last time I saw it."

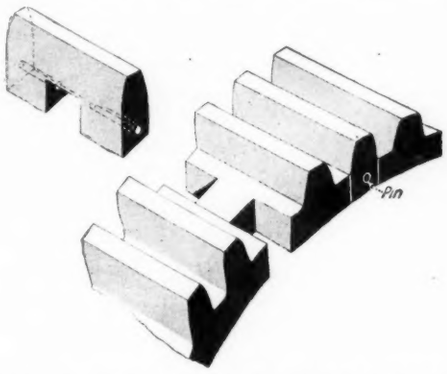


FIG. 4. SLOTTED TOOTH PINNED TO GEAR RIM

"Another trick in the game of repairs," said I.

"Yes," answered Hunter. "That same hoist had another repair job. When the gear spokes were broken, the frame was also cracked. You see the bearings for the small gear shaft were attached to the inside of the box frame, and of course that was just where the frame broke. It was patched with angle irons made out of ¾-in. stock and bolted in place. The bottom of the bearing came inside of the frame, and to prevent its lifting and tearing the angle irons out of place an anchor plate was secured to the inside bearing cap by means of the cap-bolts. From the plate a chain and turnbuckle was carried at an angle to an anchor ring-bolt embedded in the foundation. Tightening the turnbuckle of course tended to hold the bearing in place. This sketch will show about how the job was done," showing Fig. 5.

"You seem to be full of repair jobs this afternoon. Suppose you shoot again; it is rather interesting."

"Sure thing," replied Hunter, drawing hard at his pipe, which seemed to be on the point of going out.

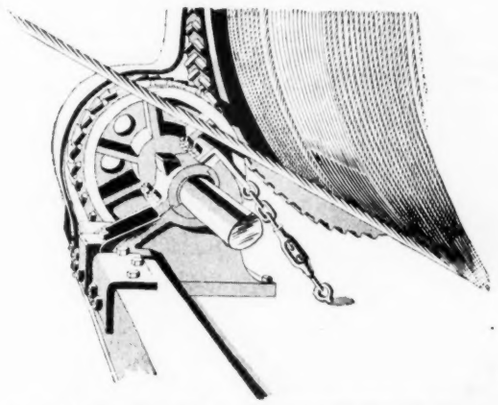


FIG 5. CRACKED HOISTING ENGINE FRAME AS REPAIRED

"I recently ran across a compressor frame that was cracked from the bottom of the bed up about a foot. Now one of the main reasons why the bed of an engine or air compressor cracks is because it is not placed on a suitable foundation, or the anchor bolts are allowed to work loose and stay so. Sometimes no foundation at all is provided other than the floor of the compressor room. Of course, a good concrete foundation is necessary.

"Well, the crack was there, no matter what the cause, and it was up to the machinist to make it good for further service. At the time the job was done I don't suppose that they knew much about this oxy-acetylene welding (which by the way will make a cracked frame as good as new if the job is done right) and so a patch had been riveted on over the crack. I'll make a sketch," and Hunter drew Fig. 7. "The patch was made of ½-in. steel plate so as to fit on the heel of the bed and reach above the crack on the side of the base. About 40 rivets were used on the plates, the original rivet heads coming inside the frame.

"Here is another stunt. The steam chest of a Corliss hoist cracked slightly, and in order to prevent it from growing, a small hole was drilled at the end of

the crack and then plugged. As a means of preventing the crack from opening up with the steam pressure, a piece was made long enough to reach across the end of the cylinder and drilled at the ends for 1¼-in. rods. On the frame of the engine beyond the crosshead two anchor pieces with rod holes drilled in them were bolted in place. A 1¼-in. rod was put through each anchor to the head. The other end of the rods came through the holes in the cross-piece, and the nuts tightened up, about like this," and Hunter sketched

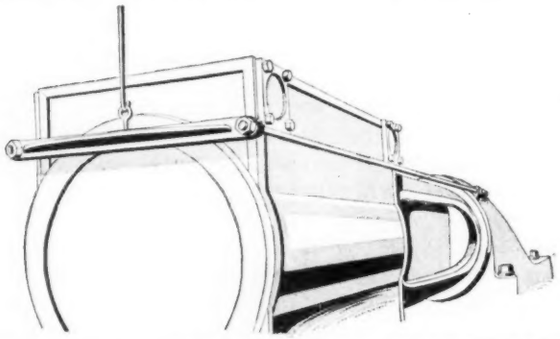


FIG. 6. HOW A CRACKED CYLINDER WAS REINFORCED

Fig. 6. "That seemed to do the trick, and the cylinder has been running with that repair for a long time."

"Hunter, you are doing better all the time. Now give me another for full measure and then it will be time to make tracks for the Baltic if we expect to get back in time for supper."

"It is about time to make tracks. Let me see. Well, here is one that is different. A cylinder head on the steam end of a compressor cracked. I don't know how badly, because I only saw the outside of it after it had

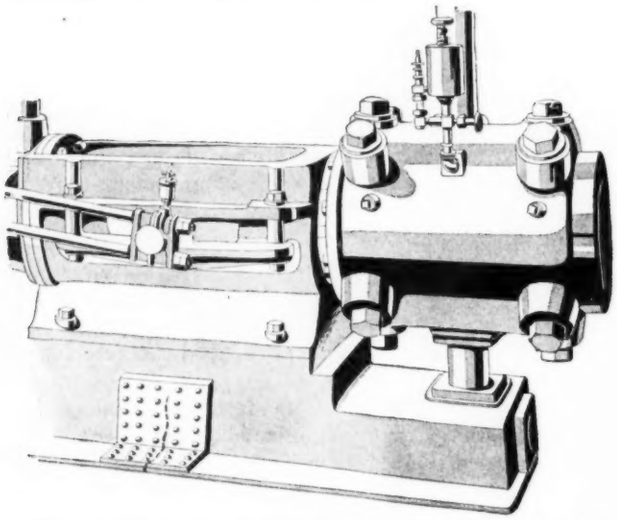


FIG. 7. PATCH ON CRACKED AIR-COMPRESSOR FRAME

been patched. However, a false head was made out of ⅝-in. thick iron and holes were drilled for the stud-bolts, the original ones having been replaced by longer ones. The repair looked about like this sketch," and Hunter proceeded to draw Fig. 8.

"Three 2 x 2-in. cross-pieces were made long enough to reach across the false cylinder head and give a bearing for four 1 x 3-in. vertical pieces, two at each end. Between each set of two vertical pieces two 1½-in. horizontal rods with an eye at one end were passed between the vertical pieces with a large washer and nut on the threaded end.

"At the other end of the cylinder two pieces of 1 x 3-in. iron were bent double with space for a 1½-in. rod at both top and bottom, and the whole bent to fit in be-

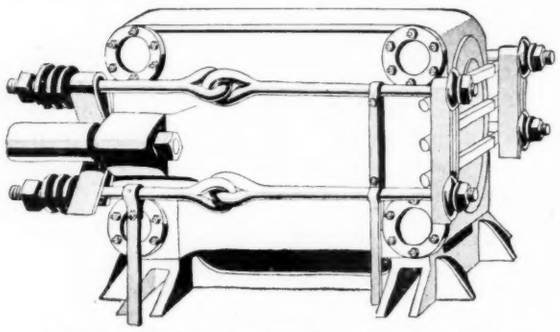


FIG. 8. HOW A CRACKED CYLINDER HEAD WAS STRENGTHENED

hind the distance rods between the steam cylinder and the frame, but bent so that the top and bottom ends came out past the side of the cylinder. These bent pieces carried the opposite end of the eye-bolts, which were also fitted with large washers and nuts. When the nuts were tightened up, the false head was reinforced and the tendency for the cracked portion of the cylinder to open up was greatly decreased. It didn't make a very nice looking job, but it did the business.

"I forgot to mention that the cylinder cracked a little at the stud-bolts and to reinforce that portion a ring was forged and pressed on over the stud-bolt rim while hot. When it shrunk, it tended to pull the cracks together.

"Now here is a last one, and then we will go. Did you notice the manner of driving the air pump on that quadruple compressor we saw yesterday, by means of

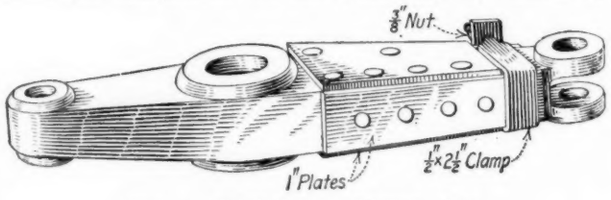


FIG. 9. REPAIRED ROCKER ARM

a rocker arm and a crank on the end of the compressor shaft?"

I replied that I had.

"That brings to mind a method of repairing a similar rocker arm that I once saw. The arm had cracked, and it was repaired by forging four pieces of steel plate and a U-strap. The job looked much like this," and Hunter sketched Fig. 9. "Two of the plates were made the width of the rocker arm and were riveted in place by four ⅞-in. through rivets. The U-strap was placed so as to clamp the outer ends of the top and bottom straps. A cross-piece fitted over the threaded ends of the strap, and when the nuts were tightened, everything was brought up snug and tight. Two side pieces, made to conform to the shape of the rocker arm, were secured in place by six through rivets. That made a pretty good job of it, and the rocker arm was still in use the last time I saw it."

At this point, we arose and continued on our way to the Baltic mines.

Uniflow-Engine Automatic Exhaust Valve

The object of auxiliary exhaust valves on uniflow steam engines is to delay the commencement of compression and thus prevent excessive pressure in the cylinder toward the end of the compression stroke should the vacuum fail, or if desired to operate a condensing engine noncondensing without the addition of clearance space which would otherwise be necessary. When the engine is operating condensing, these valves are inoperative.

These auxiliary valves are designed to operate in several ways. One design is in the nature of a relief valve of the poppet type placed near the bottom of each cylinder head. With the loss of vacuum and over-compression, the valves automatically open and connect the clearance space of the cylinder with the steam space in the head and the communicating steam piping.

Eccentric Operated Valve

Another design is that of poppet valves that are operated by eccentrics that slide on a block that is keyed to the eccentric shaft. The eccentrics can be moved by hand or automatically into any position on the block to effect closing of the valve at any point of the stroke and thus obtain any degree of compression. Another method of meeting the condition due to a loss of vacuum is that of providing a clearance pocket the connection of which with the cylinder is controlled by a valve that may be opened either by hand or automatically.

In still another design of uniflow engine the auxiliary exhaust valves are operated mechanically by the engine live-steam valve gear through the agency of cams that lift the auxiliary valves, each one being provided with a spring with just enough tension to insure quick closing. When the vacuum reaches a predetermined point, it overcomes a spring tension on the camshaft, which operates each exhaust valve, and an idler piece is drawn out of register with the cam. The auxiliary exhaust valve therefore remains closed when there is a vacuum in the exhaust pipe. Although automatic in going in and out of action, the valve is mechanically operated by the engine valve gear.

Automatic Valve Gear

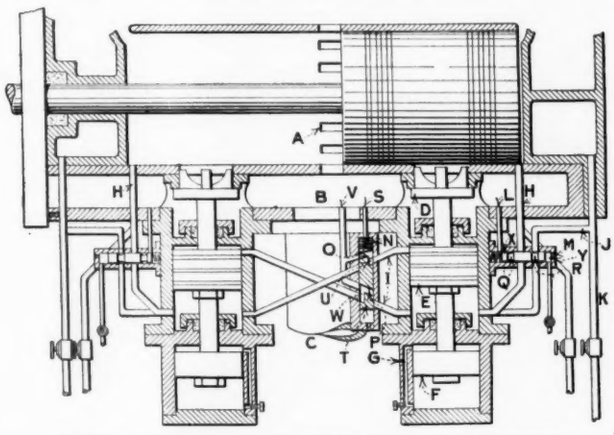
A device whereby the auxiliary exhaust valves of the uniflow type of engine are automatically operated without the aid of an eccentric or other gear has recently been patented by Axel C. Hansen, 111 Eighth Ave., New York City. The object of the device is to enable the engine to which it is attached to automatically operate either condensing or noncondensing.

In the accompanying illustration is shown a sectional elevation of an engine cylinder and the valve device, the cylinder exhaust ports *A* being in connection with the exhaust chamber *B* and exhaust pipe *C*. The auxiliary exhaust ports are controlled by its valves *D*. The stem of each valve carries a piston *E*. The stem extends through a bottom stuffing-box and carries a piston *F* in a dashpot that is fitted with a bypass *G* to cushion the lift and drop of the valve. A pipe *H* leads from the cylinder clearance space at each end of the cylinder to below the piston *E*. These spaces are cross-connected by the pipes *I* to the upper sides of the pistons.

With the engine running noncondensing, steam, admitted to the right end of the cylinder, passes through the pipe *H* and forces the piston *E* upward, which movement forces the valve *D* to its seat. At the same time steam passes from the space below the piston *E* to that above the opposite piston on the exhaust end of the cylinder and forces down that piston, which opens the valve at the exhaust end of the engine cylinder, and as the engine piston moves toward the left, auxiliary exhaust takes place past the valve to the chamber *B* until the piston overruns the left valve port. The right valve remains closed until the return stroke, so as not to lose any of the steam expansion until the main ports *A* are uncovered.

Meanwhile the exhaust in the space above the right piston passes to the space below the left piston through the pipe *I* and flows out through the left pipe *H* to the exhaust. On the return stroke the reverse operation takes place, the valve *D* at the crank end of the cylinder closing and the other valve *D* opening.

When it is desired to operate the engine either condensing or noncondensing, a pipe *J* is connected to the valve casing and to the pipe *K* and the passage of steam through these pipes is controlled by a reciprocating plug valve *Y* against which a spring presses and normally holds the valve in such position that the pipe *H* is open and the pipe *J* is closed. When the valve is shifted against the tension of the spring, the pipe *H* is closed and *J* is opened, as shown. An exhaust passage *L* connects the valve casing on the spring side of the valve with the exhaust space *B*. The pipe *H* is fitted with a drain connection, as is also the valve casing, which has an air bleeder *M* at the outer end.



SECTION THROUGH HANSEN UNIFLOW-ENGINE EXHAUST VALVES

A valve is provided for controlling the cross-passages *I*, the spring *N* presses the valve *T* down, and the ports *O* and *P* are connected with the pipes *I*. When the engine is running condensing, the valves *D* must, of course, be held closed. When the exhaust chamber *B* is under vacuum, the connection through the pipe *L* exhausts the pressure from the spring end of the valve and the air pressure shifts the valve inwardly, compressing the spring and closing the ports *Q* and the pipes *H* and opening the port *R* and pipe *J*. This action admits steam pressure below the piston *E*, and lifting the same closes the valve *D*. At the same time the exhaust is drawn through the pipe *S* and the controlling valve *T*, which is lifted by air pressure against the tension of the spring

on the top side and shifts the valve to a position so that the cross-connections between the valve casings are closed. The space above the right piston *E* then communicates through the offset *U*, port *O*, and pipe *V* with the exhaust chamber *B;* the space above the left piston *E* communicating through the offset *W*, port *P*, and the pipe *V* with the exhaust space *B*. The pressure above the piston *E* is then relieved while there is a vacuum in *B*. If the vacuum fails, the springs *X* and *N* act to shift their individual valves to their original position and the valves *D* operate the same as when the engine is run noncondensing. It will be seen, therefore, that with the employment of this particular design of auxiliary exhaust valves that the engine will automatically operate condensing or non-condensing.

Medical Treatment Under Workmen's Compensation Laws

By Chesla C. Sherlock

Employers are required to furnish medical treatment to injured employees, under the workmen's compensation acts. The amount of aid required and the length of such service vary in different jurisdictions, but the average is for a period not exceeding fourteen days after the date of injury or $100 in amount.

The amount of medical treatment is ordinarily based upon the extent of the waiting period, together with a reasonable money value calculated to cover the average fee reasonably due in ordinary compensation cases.

It is well established, as a proposition of compensation law, that the employer has the right to designate the physician that his injured employee shall consult, provided such designated physician is of ability and competent in his profession. A workman may refuse to accept the physician offered if he has reasonable cause for so doing, but the question of what is included in the term "reasonable cause" is a fruitful source of disagreement.

Employment of Physician

Where the physician designated by the employer is of recognized ability and standing in his profession and cannot be successfully charged with incompetency, the workmen will be bound to accept his services and submit to such treatment as he may indicate. Of course, the employee may still refuse such services, but in that event the employer is relieved from all claims the workman may have on him for medical treatment, and such relief may extend even to the point where it would release the employer from any liability for compensation due as a result of the injury.

The employer, however, must furnish competent medical aid to his employees. The California commission has said that it would not sanction the attempt of an employer to secure an injured employee the cheapest medical aid obtainable in each case of injury. When asked what it deemed a sufficient compliance with the law requiring medical aid to be furnished, the commission held: (1) The physician most quickly obtainable should be summoned; (2) the employer should furnish instruction as to further treatment; (3) if insured, the insurer should furnish the employer with definite instruction to be followed in case of accident.

In case of injury it is not necessary for an employee to request medical aid of his employer. The employer is in duty bound to furnish proper treatment, and if he has knowledge or notice of the injury and fails to furnish such aid within a reasonable time, to be determined by the circumstances of each case, then the employee may go to the physician of his own choosing. The employer, in the latter event, would be liable for such services as the physician might render the employee, although he had had nothing whatever to do with designating him.

The mere posting of a list of physicians which injured employees may consult or call in case of injury has been held not to be a sufficient compliance with the law requiring employers to furnish medical aid. Where an employer has failed to furnish emergency treatment, which the employee has secured on his own motion, and the employer subsequently offers competent medical treatment, the employee must accept it if he would hold the employer liable for such services.

Employee Abandons Physician

When the employee abandons the treatment of his employer's physician prior to recovery, there is a difficult question as to the amount of compensation he is entitled to recover. Hernia presents the most frequent example of this point. A workman receives a hernia, but for reasons peculiar to himself refuses to undergo an operation. Competent medical testimony has shown that the usual period of disability following an operation for hernia should not exceed two to three weeks. Inasmuch as hernia is a partial permanent disability, there is always contention on the part of the workman that compensation should be paid on such basis, but the commissions seem to take a contrary view. It has been held in several instances that the amount due the workman where operation is offered and refused, is the length of disability likely to have followed had the operation been performed.

Cases of Frequent Occurrence

Other cases of frequent occurrence and of no less difficulty are where the workman, while under the treatment of his employer's physician, calls in his own family physician. Cases of this nature are perhaps as common to compensation practice as sand is to the seashore. The rule is that unless the family physician has been called by the employer or someone in authority representing him, the employer is not bound to pay for his services, but the doctor must look to the workman for his fee.

Where reasonable medical service is offered by the employer, the employee is bound to accept it if he would successfully claim compensation. A workman must take reasonable care of himself and do all that he can to hasten a speedy recovery. He must not jeopardize the rights of the employer by refusing all medical aid whatsoever and by otherwise endeavoring to defeat what rights an employer may have under the law. A workman should recognize the economic purposes back of this legislation and minimize his period of disability as far as possible.

The specific questions that arise under this subject are necessarily a matter of local consideration. The state statutes govern in each locality and should, of course, be followed in all cases where matters of purely local concern are to be ascertained.

McEwen High-Compression Oil Engine

The high-compression, heavy-oil engine has become an important type of prime mover. Based on the Diesel principle, the engine is differentiated into many types by engine builders. The McEwen engine is of the four-cycle, high-compression type, operates on the Diesel principle and is adapted to burn any kind of heavy crude oil or residue.

ANOTHER high-compression oil engine of the Diesel type has entered the field. It is the product of McEwen Bros., Wellsville, N. Y., is of the horizontal type, and is constructed in capacities of 65, 100 and 150 hp. per cylinder. The corresponding cylinder diameters and the strokes are 14 x 22 in., 16½ x 25½ in. and 20 x 31 in., with speeds of 240, 215 and 175 r.p.m. respectively.

An idea of its design and construction may be gained from Figs. 1 and 2, from which it will be seen that the inlet and exhaust valves are vertical and the fuel injection nozzle is in the center of the head. The operating camshaft, driven by a gear on the crankshaft, is supported independently of the cylinder, so that the cam thrust is taken up directly by the engine foundation, thus relieving the frame of stresses from this source. To take off the cylinder head it is necessary only to disconnect the exhaust pipe and fuel line, knock out the pins on the valve levers and remove the nuts from the head-bolts. The design provides fewer bolts than are usually found in such engines, but they are larger and have a finer thread to facilitate taking up. Fig. 7 is a horizontal sectional view of the engine.

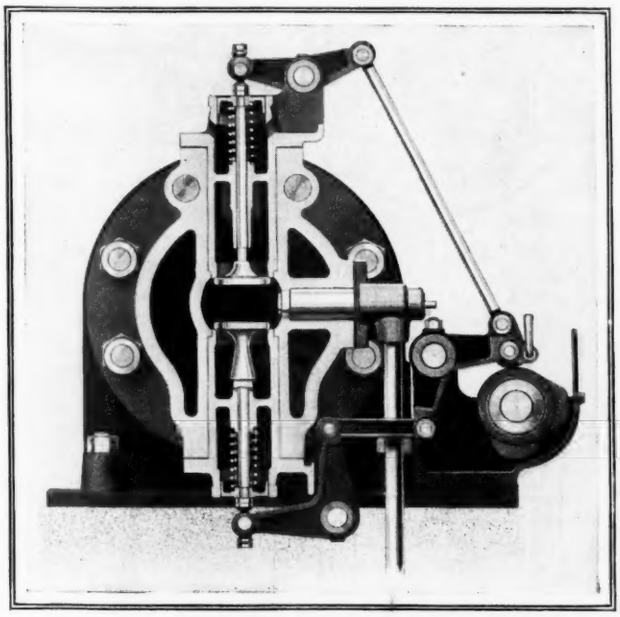


FIG. 2. SECTION THROUGH VALVE CHAMBER

The piston is in one piece, having a conical head without ribs; it is of the trunk type and is air-cooled. A marine-type connecting-rod is used. The boxes are

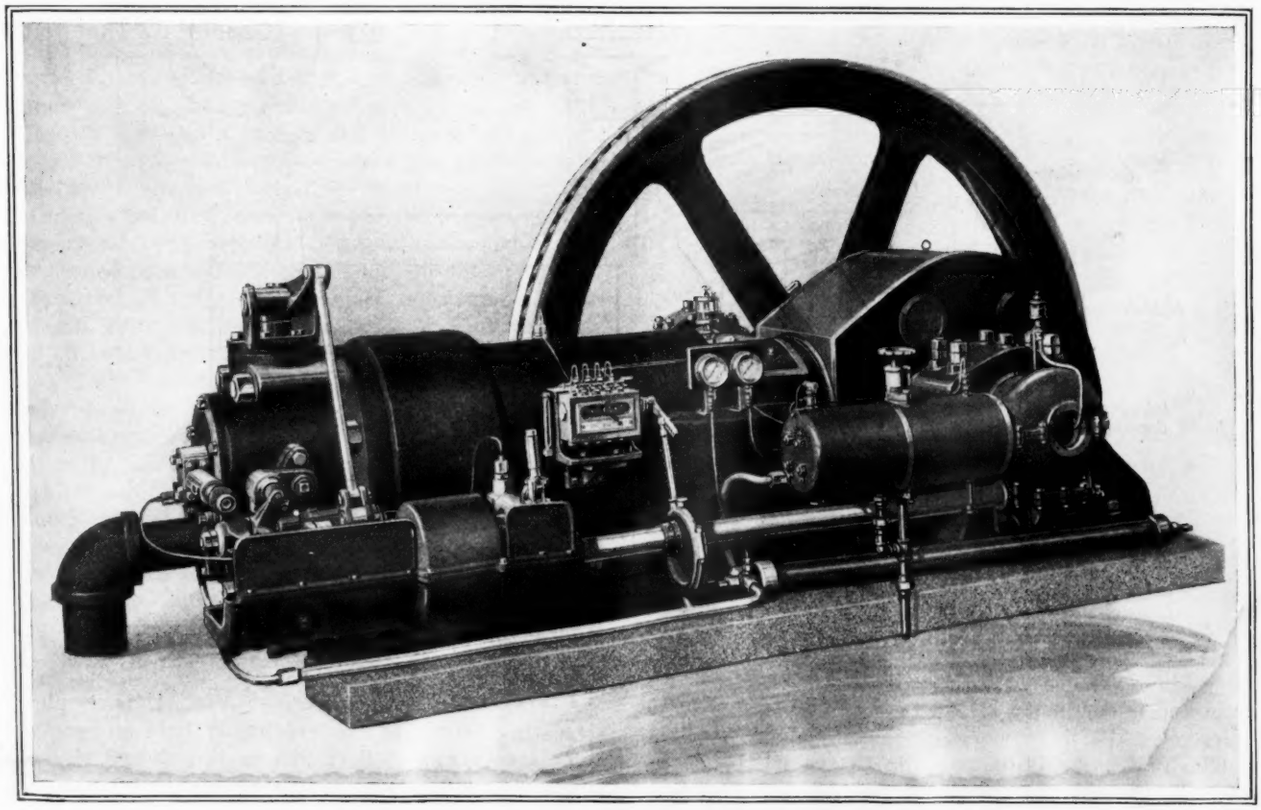
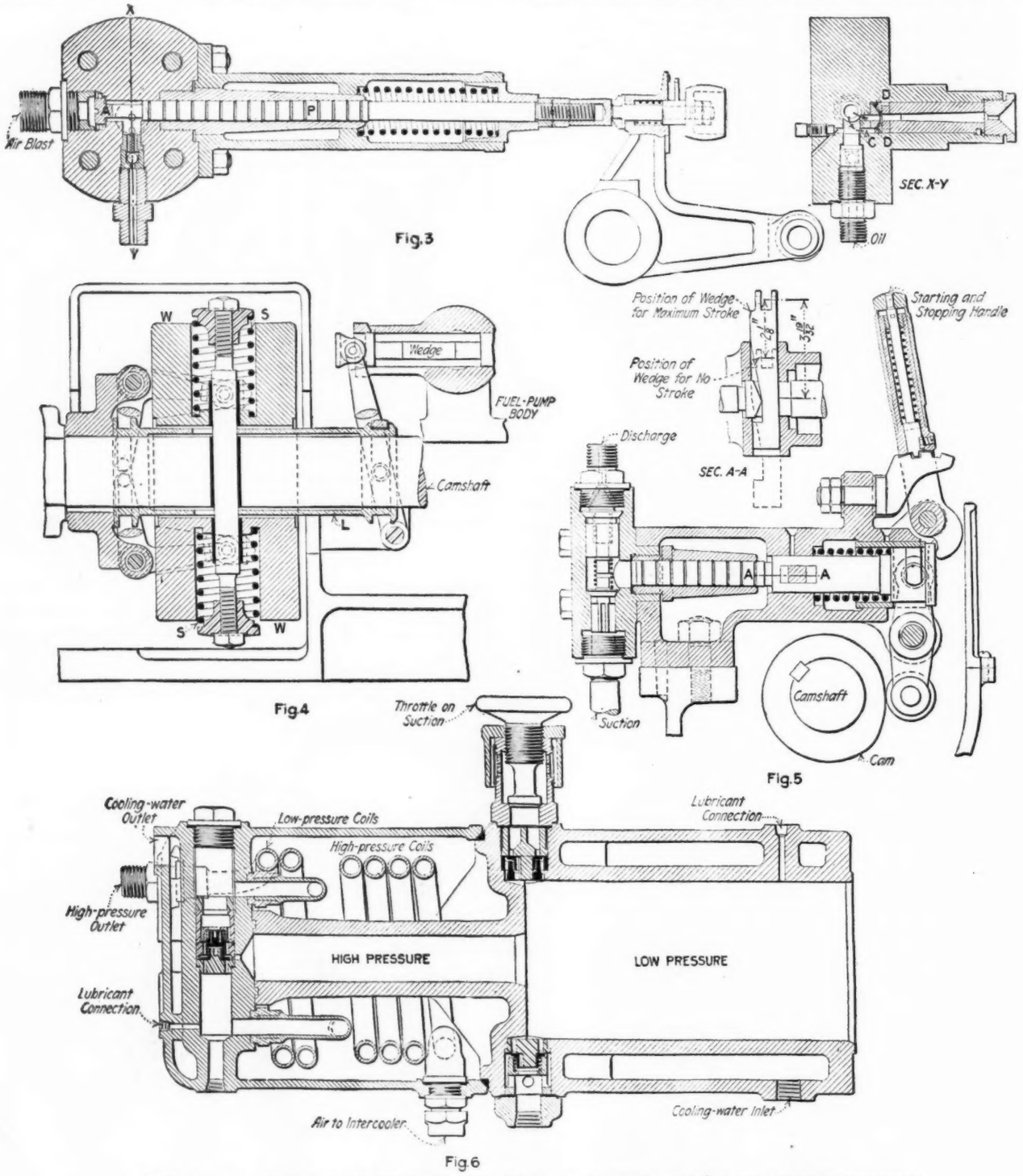


FIG. 1. THE MCEWEN HIGH-COMPRESSION OIL ENGINE

bolted to the rod end and are provided with solid liners to allow for their adjustment to the pin. The length of the rod and thus the compression may be altered by inserting distance pieces between the rod and the boxes. Air for combustion is drawn in through the crank case and is conducted by channels in the frame, to the inlet valve.

The fuel pump is mounted on the camshaft-bearing case close to the governor. As with the fuel nozzle, no stuffing-box is used, the plunger being casehardened and ground. The plunger is operated against a spring, and the return stroke is controlled by a wedge which is actuated by the governor, as shown in Figs. 3 and 4. A starting and stopping handle is provided for engaging and disengaging the pump as shown in Fig. 5.



FIGS. 3 TO 6. DETAILS OF FUEL VALVE, GOVERNOR, FUEL PUMP AND AIR COMPRESSOR
Fig. 3—Fuel valve. Fig. 4—Governor. Fig. 5—Fuel pump. Fig. 6—Air compressor

A simple form of governor, Fig. 4, is employed, consisting merely of the weights *W* held by springs *S* and connected by bell cranks to the sliding sleeve *L*, which in turn connects with the wedge previously mentioned. Thus, as the speed increases the weights fly out

farther, causing the bell cranks to slide the sleeve to the right and in turn shove the wedge in farther. This shortens the return stroke of the pump, decreases the suction and feeds less fuel to the spray nozzle.

The open-type fuel nozzle, shown in Fig. 5, is used. The oil is pumped in, as indicated, past the ball check and into the eccentrically located space *C* (see section XY). When the air valve *A*, Fig. 3, is opened by the plunger *P*, the blast of high-pressure air divides, part passing through the central opening, and part behind the oil, as indicated by the arrows in section XY of Fig. 3. A difference of pressure is thus set up, and the oil is forced through the channels *D*, mixing with the air in the central chamber, the expansion of the air tending further to atomize the oil, the mixture finally shooting through the atomizing plate at the end of the nozzle.

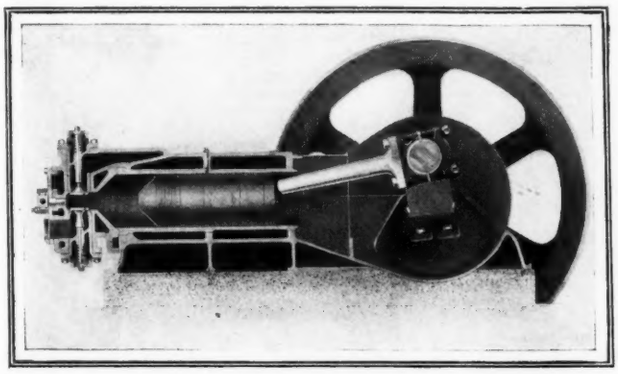


FIG. 7. SECTION THROUGH MC EWEN OIL ENGINE

A two-stage air compressor, self-contained in a single barrel, is carried on the engine frame and driven by a small crank on the end of the mainshaft. As shown in Fig. 6, the first- and second-stage cooling coils are integral with the combined high-pressure head and water jacket. The suction and discharge valves are interchangeable, and in the case of the low-pressure end are mounted in easily removable cages. The high-pressure air delivers to the fuel spray line, which is provided with a seamless steel tube receiver to prevent any fluctuation in pressure. The pressure and output of the compressor is controlled by a throttle on the suction line of the low pressure end, and when it is desired to charge the starting tank, this throttle is opened and the charging air taken off between the high- and low-pressure stages; see Fig. 1. The air-starting valve is in the side of the cylinder head, as shown in Fig. 2.

The cooling water first comes to the compressor, then is passed to the engine-cylinder jacket, and finally to the cylinder head. Neither the piston nor the exhaust valve is cooled. Based on 50 deg. F. entering temperature and 140 deg. F. exit temperature, the builders estimate a water consumption of approximately 3½ gal. per hp.-hr.

The engine is fitted with a standard Richardson-Phœnix force-feed lubricator driven by an eccentric from the main camshaft, and the bearings have two oil rings each. A special arrangement is provided for oiling the wristpin. The skirt of the piston is slightly tapered on top, and bearing on this upper face is a ball wiper receiving oil from a sight-feed cup on the top of the cylinder. From this space the oil is fed by a pipe within the piston to the wristpin.

In the smaller size the weight per horsepower of the engine complete is 440 lb. In rating the engine a conservative mean effective pressure of about 68 lb. is figured on, allowing for a 10 per cent. overload for 2 hours, although the engine has actually carried for a short period as high as 25 per cent. overload.

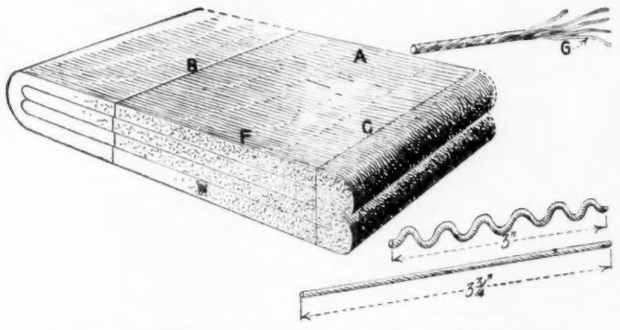
Testing and Specifying Cotton Belts

By James F. Hobart

The belting bills in a flour mill are usually large. The engineer and the millwright of an Indiana mill cut the belting cost almost in half by the use of stitched cotton belting that stretches but little and gave results equal to the leather belts. They found, however, that some belting of this kind would stretch considerably, necessitating frequent "taking up" and eventually becoming much narrower than when purchased and incapable of transmitting full power. They cast about for some means whereby they could pick out good belts from the samples offered and finally worked out a series of tests from which they were able to make up specifications that brought good belting every time and excluded the inferior quality.

These simple specifications were as follows: The belt canvas or duck shall have an equalized weave; its possible elongation shall be not more than 30 per cent., or less than 20 per cent., preferably about 25 per cent.; equal number of threads in the yarn of both warp and filling, preferably five or six; the impregnating material may be either of an oily or of a paraffin nature.

To determine just what the foregoing specifications mean, secure several samples and experiment a little. First, cut a section three inches square, and remove one of the threads from the warp and another from the filling, as shown in the sketch, *A*, and *F*, *B* and *C* being three inches apart and the sides being cut square and smooth. It is not necessary that three inches square be



SAMPLE THREADS TAKEN FROM CANVAS BELT

taken as the size, but it is necessary that the test piece be square. One side must not be longer than the other, and three inches was selected because that is about as large as can be obtained from the samples carried by belting salesmen.

With a sharp-pointed knife pick out a thread of warp alongside *C* or *B* and a thread of filling along side *A* or *F*, being sure that these threads are full size and have not been damaged by the cutting off of the belt; it is therefore better to pull out one thread and throw it away and take the next thread for a test sample. The test consists of measuring the elongation of the threads

and an examination of the weave. The threads, or yarn as the weaver calls them, when removed, will present a wavy appearance, as shown at *E*. By the time the thread has been picked out, it will naturally be somewhat straightened out and be more than three inches long. Note about how hard the thread is twisted, then straighten out the curves by drawing the thread between the thumb and finger several times until it lies quite straight, and holding one end fast, twist the other end until the twist is the same as before the thread was straightened. Do not neglect this point, for it is important in order to make an accurate test and the thread will naturally lose some of its twist during the straightening operation and be longer than if the twist was not removed. The thread should then be laid beside a rule and measured. The sample shown in the illustration proved to be 3¾ inches long after straightening and returning the lost twist.

Comparing the Stretch

Comparing the straightened length with its length while in the belt, it is apparent that the thread or yarn has elongated ¾-in., or 25 per cent. This "possible stretch" is not what the belt can stretch during use, for it can never elongate that amount, but is used merely as a basis for comparing threads or yarn from different belt samples. The engineer and millwright found that when the threads showed a greater elongation than 25 per cent., the cotton duck of which the belt is made was too loosely woven to give good service, and with less than 25 per cent. elongation the belt would not wear as well as if a little more loosely woven and that 25 per cent. represented the "golden mean" between stretch and break and gave the best service of all the samples tested and used. It was also found that the best belts showed the same elongation in yarn taken from both sides. One thread or yarn from each side should be partly unraveled, as shown at *G*, and the threads in each carefully counted, for in some cases there may be more threads in one than in the other. (Weavers call the twisted strands "yarn" and the parts of each yarn "threads," to avoid confusion between the strands and the threads of the warp or filling.)

Threads in the Yarn Should Be Equalized

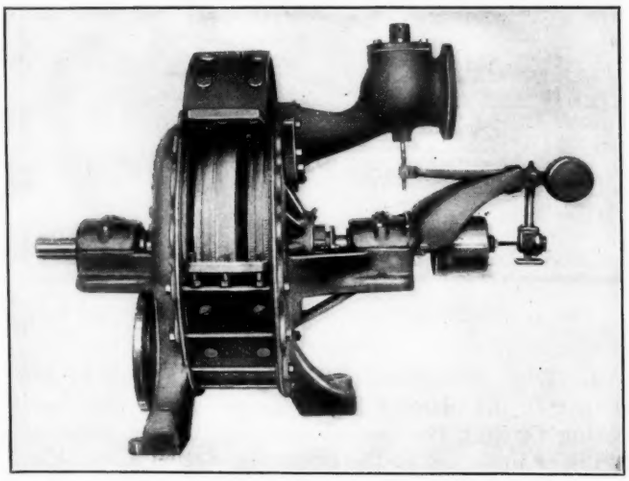
It is also important in the selection of a belt that there be the same number of threads in the yarn of both warp and filling. It is then said that the "weave is equalized," and a belt made from such duck will be far better than if made from duck with an unequal number of strands. It does not make much difference, however, whether there are five or six threads in the yarn, but more than six threads makes a heavy, cumbersome duck that does not wear as well as one having five or six threads in its yarn—warp and filling. After the test, label the sample with date, where obtained and results of the test, and file it away for a duplicate test at any time. It is especially desirable to keep such a sample of belts in use.

Some of the belts tested appeared to be filled—"stuffed" the belt makers call it—with a preparation resembling linseed oil, while others seemed to be stuffed with a substance having a nature or feeling much like ordinary paraffin. Little difference was found in the wearing or lasting qualities, therefore belts could be accepted with either kind of filling.

Curtis Auxiliary Steam Turbine

The General Electric Co., of Schenectady, N. Y., has developed a Curtis steam turbine in a wide variety of capacities to drive fans, blowers and pumps for boiler feeding and circulating systems.

It is called the Type L and is of the impulse type. The number of stages and rows of buckets vary with the capacity. A split wheel casing is used to permit ready inspection of the buckets, which are of bronze dovetailed into the rim of the wheel. The speed may be



TURBINE WITH SECTION OF CASING REMOVED

changed by handwheel adjustment while the turbine is in operation. A constant running speed is maintained by a governor mounted directly on the shaft and controlling a double-balanced piston-valve type throttle.

The mainshaft carrying the rotor and governor runs in babbitted bearings with renewable linings, and is fitted with readily accessible packing glands. Three feet support the frame of the turbine to insure the bearings always being in line.

Solution for Absorbing CO_2

The most important constituent of flue gas, affecting economy, is carbon dioxide (CO_2). To find what per cent. of the total volume of a sample is CO_2 the usual method is to take out the CO_2 and see how much gas is left. A solution of either "caustic soda" (sodium hydroxide, NaOH) or "potash" (potassium hydroxide, KOH) will absorb CO_2 when the two are brought into contact. A 33 per cent. KOH (caustic potash) solution is the most commonly used and is made as follows: Dissolve one part of KOH (stick form) in two parts of water, by weight, and allow to stand until thoroughly cooled before using. This will absorb from 35 to 45 times its own volume of CO_2. If the capacity of the measuring burette is 100 c.c., a pipette of the same size, containing the solution, may be used to make 350 to 400 determinations averaging 10 per cent. CO_2 each, and a complete absorption of CO_2 should not take over three minutes. The potash may be purchased at almost any drugstore; the chemically pure (c.p.) stick form is preferable for this work. Care should be taken in handling the caustic potash as it attacks the clothing and skin. Air has but little detrimental effect on the solution, but it should be kept stoppered.

Coal and Ash Conveyor Tests

By L. A. Quayle
Chief Mechanical Engineer, Cleveland Water-Works Pumping Station

The accompanying table gives the result of tests made on three coal and ash conveyors to determine whether the motors and conveyors conformed with the specifications on which they were purchased.

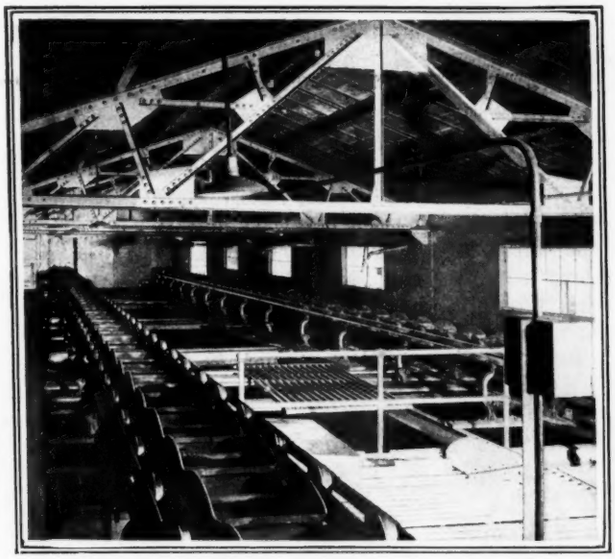


FIG. 1. VIEW OF NOS. 1 AND 2 CONVEYOR

Although the running load on the motors of the Nos. 2 and 3 conveyors was less than three-quarters full load, considerable difficulty was experienced in starting with the buckets full of coal until the conveyors had been limbered up by runs totaling nearly 100 hours. After the tests were made, both conveyors readily started and

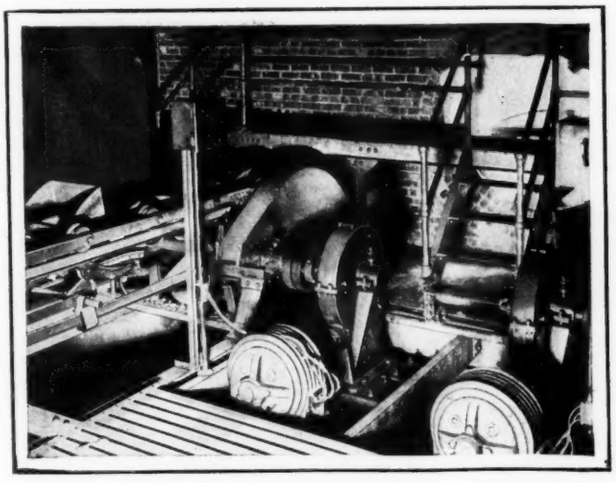


FIG. 2. WORM AND SPUR REDUCTION GEAR OF THE CONVEYORS

stopped several times, with the buckets filled. The starting input to the motors was 24 kw., or approximately four times the running input.

The higher mechanical efficiency obtained on Nos. 2 and 3 conveyors over that obtained on No. 1 was mostly due to the increased lift of 19 ft. 8 in. and the fact that they were handling over 50 tons per hour instead of approximately 40. The squirrel-cage motors used on the Nos. 2 and 3 conveyors are also somewhat more efficient than the direct-current motor on the No. 1 conveyor.

The three conveyors were made and installed complete by the Link-Belt Co., of Chicago, No. 1 costing $5242, and Nos. 2 and 3 costing $3988 each.

Fig. 1 shows Nos. 2 and 3 conveyors and Fig. 2 shows the worm and spur reduction gearing which drive them. No. 1 conveyor was illustrated in the Mar. 7, 1916, issue of *Power*.

TESTS ON THREE MOTOR-DRIVEN COAL AND ASH CONVEYORS AT WATER-WORKS PUMPING STATIONS

Date of test	Jan. 16	Apr. 17	Apr. 17
Conveyor number	1	2	3
Location of conveyors, station	Fairmount	Division	Division
Total number buckets in conveyor	173	170	170
Pitch of buckets, ft	2	2	2
Horizontal run of conveyor, ft	120	96	96
Total height coal is elevated, ft. in	55–0	74–8	74–8
Total length of conveyor, ft	346	340	340
Rated capacity of conveyor, tons per hour	40	40	40
Speed of conveyor running light, ft. per min.	40.0	40.0	40.0
Speed of conveyor running loaded, ft. per min.	38.2	38.8	38.8
Time required for bucket to return to starting point (loaded), min. sec	9–5	8–45	8–45
Current supplied to motor, volts	115 D.C.	220A.C.	220A.C.
Type of conveyor motor (inclosed)	compound-wound	squirrel-cage	squirrel-cage
Full-load rating of conveyor motor, h.p.	7.25	10	10
Full-load speed of conveyor motor, r.p.m.	775	1,145	1,145
Length of run, running light, min	27	30	40
Length of run, unloading coal, hr. min.	2–28	1–54	1–52
Net weight of coal in cars unloaded, tons	98.0	97.4	96.3
Rate of unloading, tons per hour	39.7	51.2	52.1
Input to motor, conveyor running light, kw.	1.76	2.1	2.0
Average input to motors, conveyor running loaded, kw	4.18	6.0	6.1
Rated continuous input to motor, kw	6.6	8.3	8.3
Act. input in per cent. of rated input	63.3	72.3	73.5
Max. motor-bearing temperature, deg. F.	120	117	113
Max. temp. rise of motor windings, deg. C.	25	15.5	18.9
Minimum allowable temperature rise of motor windings, deg. C	55	55	55
Theoretical power required to elevate coal, b.hp	2.22	3.87	3.89
Mechanical efficiency of conveyor (assuming motor efficiencies given by manufacturers are correct), per cent	49.5	54.3	53.8

Cleaning Condenser Tubes

Apropos of the discussion of the cleaning of condenser tubes which has been running in these columns, the following excerpt from an article on "Condenser Tube Corrosion" in *Engineering* of July 13, is of interest. The author has the following to say on the subject:

The practice of cleaning tubes by acids, alkalies or some of the secret nostrums on the market is questionable. If the vacuum is good and the corrosion product a thin, firmly adhering scale, I do not think it should be disturbed, since it is more likely to be protective than otherwise. On the other hand, if the tubes are choked to such an extent that the efficiency of the condenser suffers, there appears to be no other remedy than to clean them, but in any case if the deposit can be removed by a high-pressure water jet or by brushing, this is undoubtedly better than by the application of chemicals.

Boiling out the steam space of a condenser with alkalies is a practice for which some engineers have an obsession. In turbine sets, where the only oil that can reach the condenser comes from the reciprocating auxiliary machinery, this seems hardly necessary, more especially since the modern tendency is to reduce cylinder lubrication to a minimum and the oils used are mineral hydrocarbons, on which soda has no action beyond a possible slight emulsifying effect. A thin film of mineral oil can do no harm, and I have even suspected this as the protective influence on those tubes that resist corrosion, such tubes as I have examined having had a slight greasy coating on the inside.

Synchronous Motor Operation—I

By GORDON FOX

The construction and operating characteristics of the synchronous motor are discussed with particular reference to its starting characteristics.

IF TWO alternators are connected in parallel and the prime mover of one unit is shut down, this alternator will continue to rotate in the same direction and will pull its engine. As long as the unit operated as an alternator, having outgoing power, its torque opposed that of its prime mover. With incoming power, the torque is reversed, so that it does not oppose rotation, but maintains it. A synchronous motor is, in theory, a synchronous alternator receiving power from the mains instead of feeding into them.

The rotor of a synchronous motor, Fig. 1, is composed of a number of radial polepieces magnetized by coils carrying direct current introduced through the rings *R*, therefore the polarity of the field poles is fixed. The stator, Fig. 2, presents a smooth core and carries a distributed winding which is similar to the stator of an alternating-current generator or induction motor.

FIG. 1. FIELD STRUCTURE FOR AN ALTERNATOR OR SYNCHRONOUS MOTOR

In an induction motor the rotor is caused to revolve by the rotating magnetic field set up by the current in the stator winding. The stator magnetic field of a synchronous motor revolves in exactly the same manner as that of an induction motor. Since the polarity of the rotor of a synchronous motor is fixed, the rotor must revolve in exact synchronism with the revolving field of the stator if unidirectional torque is to be obtained. At any other speed the torque at one instant will be forward, the next instant reversed and the motor will stall. The synchronous motor derives its name from the fact that the rotor revolves at synchronous speed regardless of its load, or else loses its torque and stalls.

In general, the torque of a synchronous motor is adjusted to the external load according to the relative position taken by the field poles with respect to the stator conductors when the current of the latter is passing through its maximum value. When the motor is running light, the axis of the rotor poles approximately coincides with the axis of the stator poles. When load is added, the rotor lags slightly, not in speed but in angular position, so that the rotor poles take an intermediate position between those of the stator.

In an induction motor a wattless current is required to magnetize the core and to set up the stator's revolving field. In a synchronous motor a north pole of the rotor will approximately coincide with a south pole in the stator, therefore the rotor field favors the stator. The stator tends to maintain a field of fixed value, just as the primary magnetism of an induction motor is held constant. Since the rotor magnetism favors the stator field, if the rotor's magnetizing influence is sufficiently strong, the stator will not have to set up its own field. When the latter condition exists, no wattless current is taken from the mains and the power factor of the machine will be unity.

If the rotor's magnetizing influence is overstrong, a demagnetizing current—that is, a leading wattless current—is drawn from the line. Conversely, if the magnetism set up by the rotor is not equal to that demanded by the stator, a magnetizing current—namely, a lagging wattless current—will be drawn from the line. It is evidently possible to control the power factor of a synchronous motor so that it may be unity or so that either leading or lagging wattless current is drawn from the mains. This is one of the most important features in the use of synchronous motors.

Small polyphase synchronous motors are usually started by induction-motor action. The application of alternating current to the stator sets up a revolving field. The rotor fields are not excited at starting. Eddy currents produced in the polepieces by the revolving

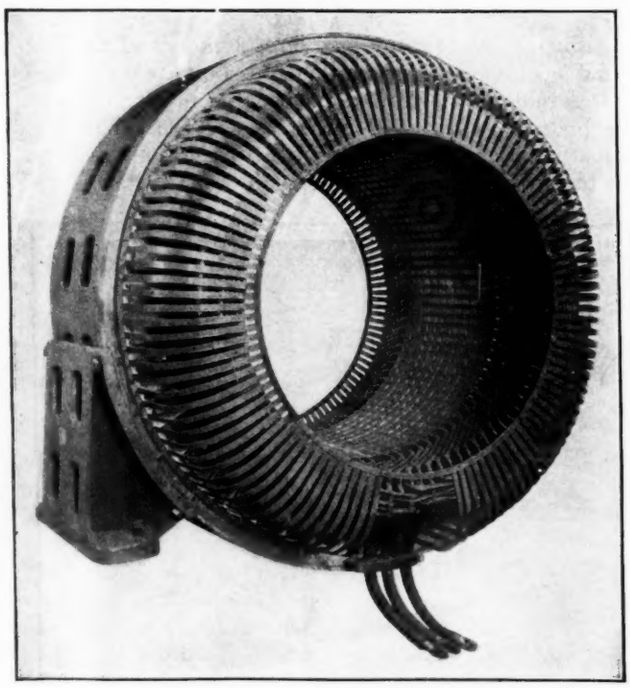


FIG. 2. STATOR OF AN ALTERNATING-CURRENT GENERATOR OR SYNCHRONOUS MOTOR

field act similarly to the secondary currents of an induction motor, producing a small torque sufficient to start the motor without load. More often the rotor is adapted specially for induction-motor starting usage, by a squirrel-cage secondary being provided by embedding copper bars in the field poles, which are short-circuited on end rings, as shown in Fig. 3. Motors thus arranged

will develop 15 to 20 per cent. of their full-load torque with approximately full-load current at half voltage applied from a starting compensator. This comparatively low starting torque requires that the motor start under proportionately small load. When the rotor has reached nearly synchronous speed, the field circuit is closed, drawing the motor into step at synchronous speed. The compensator is then thrown over to connect the stator windings directly to the line. The field rheostat is adjusted for the desired running conditions, and the machine is ready to carry its load.

While a self-starting synchronous motor is accelerating, it depends upon induction-motor action. Since an induction motor never attains synchronous speed, it follows that a synchronous motor cannot be brought to

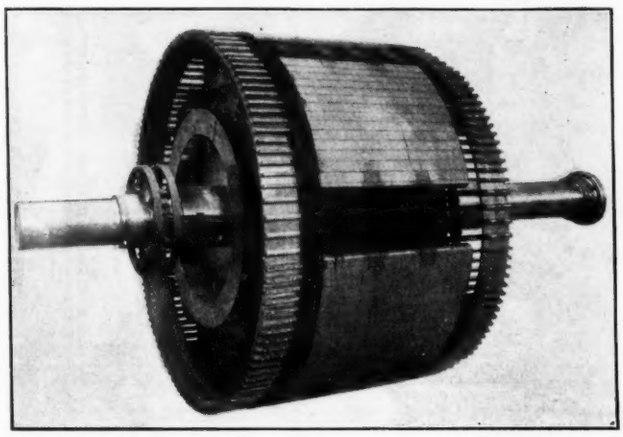


FIG. 3. ROTOR OF SYNCHRONOUS MOTOR WITH SHORT-CIRCUITED COPPER STRUCTURE IN POLE FACES

synchronous speed purely through induction-motor action. If it is brought up sufficiently near to synchronous speed, however, it will pull into synchronism. During this period the rotor fields are excited by wattless current in the stator. Because of its poorer magnetic circuit, a much higher magnetizing current is required by a synchronous than by an induction motor. There are two periods of low torque during acceleration, one at standstill and one at the pull-in speed just below synchronism.

The torque exerted per ampere input by a synchronous motor at standstill may be made quite high if the resistance of the secondary circuit (copper bars in the pole faces) is high. It is therefore the practice in some cases to use a squirrel-cage winding of brass or german silver to afford increased secondary resistance. In this manner the torque at rest is increased, but the difficulties at "pull in" may be aggravated. The slip of an induction motor is greater the higher the secondary resistance. A high-resistance secondary winding on the synchronous motor's rotor causes the machine to attain a lower speed through induction-motor action than is attained by a motor with low-resistance squirrel-cage winding. The synchronous motor action must then be stronger to overcome this greater margin.

The type of winding used will depend on the characteristics of the load to be accelerated. A fan or centrifugal pump requires comparatively little torque at rest, but may represent considerable load near synchronous speed. Here a low-resistance secondary winding would be best. An air compressor, started with open valves, requires considerable torque to overcome static friction, but may be comparatively easily pulled in at full speed. Here a higher-resistance rotor may be advantageous.

In order to provide both high starting torque and low slip, some motors are now built having wound rotors. These are star-connected and lead to three slip rings, Fig. 4. During the starting interval the slip rings are connected to an adjustable external resistance. When the motor has reached nearly synchronous speed, direct current is connected to the slip rings and the wound-rotor windings are used as field-exciting windings. Such motors are excellent at starting, but sacrifice some points in their synchronous running.

When a synchronous motor is started as an induction motor, it is desirable that the field winding be open-circuited because, through transformer action, an alternating voltage is induced in the field coils, at standstill. This voltage may be very high and would probably break down the insulation of the windings. The induced potential at starting can be held down by short-circuiting the field windings through its rheostat, but this materially reduces the starting torque. If the field be short-circuited through a high resistance, the torque is good at starting and the danger of insulation breakdown is lessened. Excitation may be placed upon the field circuit with the high resistance in parallel, and the the latter cut out. This practice is followed in occasional instances. Another practice is to use a switch to break the connections between the field coils.

It has been found that the torque at "pull in" is aided by slightly exciting the fields a little before synchronism is reached. The excitation applied should be considerably below normal, the exact amount affording maximum pull-in torque varying in different machines. It is well, after the motor has reached synchronism under reduced voltage, to adjust the excitation to that value

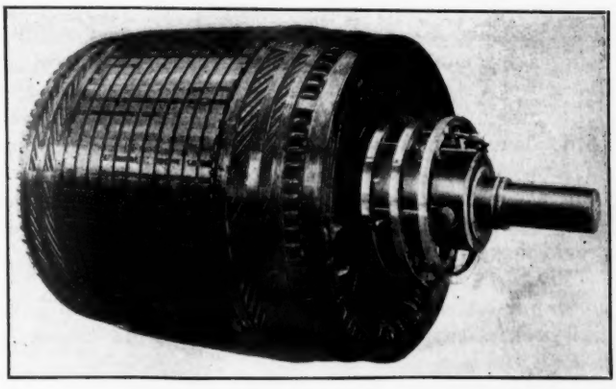


FIG. 4. WOUND ROTOR FOR A SYNCHRONOUS MOTOR

known to give unity power factor at full voltage. This will insure minimum rush of current when the compensator is thrown over to the running position. Application of excitation usually causes a little oscillation of the rotor, therefore the compensator should not be thrown from starting to running position until the rotor has settled down to uniform synchronous speed.

While the rotor is revolving without excitation in the revolving field set up by the stator, the rotor field poles are magnetized by the stator magnetism. When the direct-current exciting circuit is closed the polarity of

the rotor fields may be reversed, since the polarity of the induced magnetism is a matter of chance. Reversal of polarity causes the rotor to slip back one pole so as to assume the correct position with respect to the stator's field. This will usually cause no serious disturbance. If the action proves undesirable, it can be avoided by applying reduced excitation just before the rotor pulls into step. This not only insures the correct relation, but, as before stated, increases the torque near synchronism.

Owing to the high magnetizing current required by a synchronous motor, a heavy wattless current is drawn during the starting period and the power factor is then low. The motor will require two to three times normal kilovolt-ampere at starting if the load is appreciable, consequently the relative capacity of the generating equipment should be such that this will not have any serious effect.

Large synchronous motors are frequently arranged to be started by the use of the direct-current exciter as a motor or by means of a small auxiliary induction-type starting motor. If a synchronous motor is used as one unit of a motor-generator set, it is often possible to utilize the other unit for starting. If started by use of a small auxiliary induction motor, the latter has less poles than the synchronous motor so that its synchronous speed is greater than that of the larger machine.

Motor Primary Control

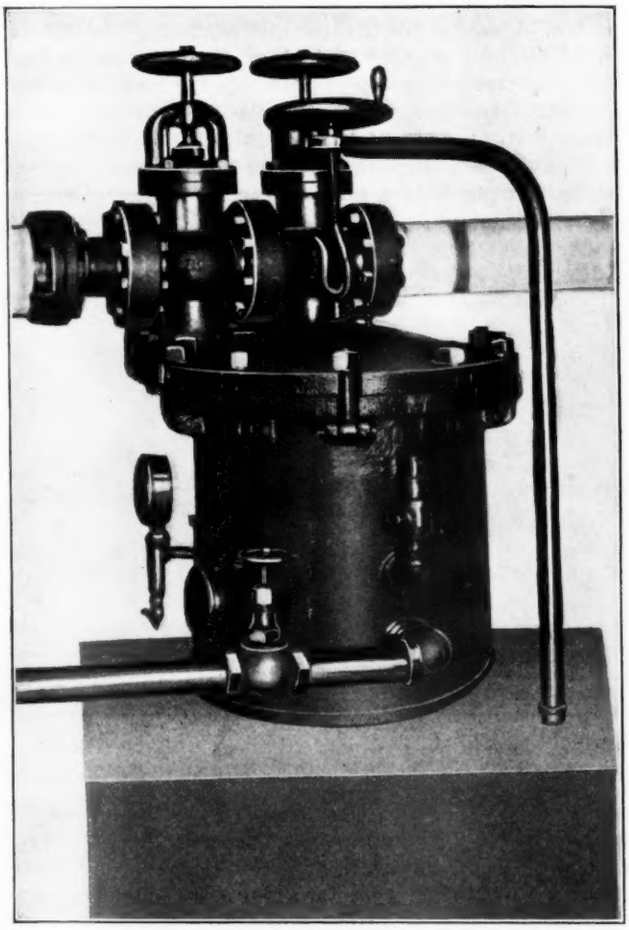
The induction motor is usually provided with rheostat or primary control so that its speed may be adjusted to secure exact synchronous speed for the large unit. The induction motor is started with the synchronous motor disconnected from the line. The latter then acts as an alternating-current generator without load. The field current is adjusted so that its voltage corresponds with that of the line, and synchronized in the same manner as an incoming alternator, using lamps or a synchronoscope to indicate synchronism. It is good practice to reduce the load at starting as far as possible, using a mechanical clutch, if necessary, to connect or disconnect the load at will.

Because of the general desirability of a single unit without auxiliary apparatus, the self-starting synchronous motor is becoming standardized and much attention is being given to its starting performance. The most recent designs show marked improvement over previous types, in this respect.

[*The use of the synchronous motor for power and power-factor correction purposes, its tendency to hunt and prevention, and its limitations will be discussed in Part II.*]

Home-Made Filter-Cover Crane

It is not always an easy matter to remove the cover of some oil filters with less than two men. The illustration shows a home-made crane that permits one man to remove and replace a heavy cover with ease. In the cement base upon which the filter rests a piece of pipe is embedded, the top coming flush with the surface of the base. In this pipe a 1¼-in. solid iron rod fits and is provided with a welded collar to give a bearing on which to swing. The upper part of the rod is bent at right angles to the vertical section and is of such length that the flat end comes central over the eye-bolt in the center of the filter head. This flat end of the crane is drilled a loose fit for the threaded shank of a hook made of ½-in. stock. On the upper side of the crane is a common lathe handwheel, which is drilled and threaded



SWINGING ARM FOR LIFTING COVER PLATE

to take the hook shank. When it is desired to remove the cover, the securing nuts are loosened and a few turns of the handwheel lifts the cover from the body of the filter, when it can be swung to one side. This little arrangement enables one man to handle the cover, whereas two men were formerly required.

Shortage of Coal in New Zealand

During the last few months there has been trouble between the coal miners and their employers in New Zealand, with the result that there is a shortage in the coal supply. The government has taken the question in hand, and for several weeks has endeavored to adjust matters. Many industries, including gas and electric plants, are handicapped for want of sufficient coal. It is difficult even to get imports from Australia, but arrangements have been made for the delivery of 30,000 tons of coal per month for a time at least. During 1914, 518,070 tons were imported, as compared with 293,956 tons for 1916. During the first three months of 1917, 515,142 tons of coal was mined in New Zealand, as compared with 637,155 tons for the corresponding period of 1916.—*Commerce Reports.*

Editorials

The National Association of Stationary Engineers

THE National Association of Stationary Engineers, which will hold its thirty-fifth convention in Evansville next week, has witnessed in the more than one-third of a century of its existence a degree of expansion and evolution in the field of its endeavors which has brought to it exceptional opportunities. At the time of its inception the electric light was just beginning to be introduced and the electric street railway was an experiment. The principal use of the steam engine was to furnish power to industries of the total cost of operating which the entire expense for power was so small a proportion that it got little attention. The loss of production through an occasional shutdown was of more moment than a continual avoidable waste which it would have taken expert engineering to detect and perhaps some investment to overcome. The largest engines, and those whose performances were most carefully analyzed, were those used for pumping water, in which case the power cost was the main item of expense.

But the cost of industrial power, although a small proportion of the cost of running a factory or machine shop, was in itself a tidy little sum, and he who could save ten or twenty per cent. of it for his employer ought to be entitled to a portion of the saving in better remuneration.

And then apart from savings or wages, engineers are so fond of "talking shop" and there is so much about power-plant engineering that is good for discussion. And there was the steam-engine indicator beginning to get popular and to imbue the operation of an engine with something more than a mechanical interest. And so it came naturally about that the little coteries of engineers that habitually assembled to discuss these things took on a more formal organization and in time coalesced into the National Association of Stationary Engineers. The ideas of organization of its founders having been derived from membership in fraternal societies, the new association took on the character of a secret society with passwords, grips and a ritual, which feature has been a handicap in overcoming the suspicion with which it has been looked upon by employers, although as a matter of fact nothing goes on behind the carefully guarded doors that the world might not know.

The developments of the thirty-five years since the birth of the association have called for power for many purposes and in unanticipated amounts. In addition to the natural expansion due to the creation of new industries and the growth of the country has come the commercial application of electricity to lighting, transportation and power distribution. It is difficult to recall that when the N. A. S. E. was organized the horse car was the principal means of intraurban transportation. Fuel, instead of being a minor item in the cost of production of electricity, is the main item. The importance of economical and efficient operation is magnified, the size of the installations both in the units used and in the aggregation under a single roof is enormously increased. The complexity of the steam plant is greater. There has developed a demand for men of executive ability, who can manage as well as operate and who possess not only a practical familiarity with all this intricate collection of machinery and instruments, but who know the fundamental principles of its operation and can adapt, design, diagnose, direct and keep it in operation at its best efficiency.

In supplying this type of man the N. A. S. E. has been an important factor, and many an engineer occupying a responsible and well-paid position can trace back the awakening of his interest, the acquiring of the study habit, the development of the faculty of analysis, which have fitted him for his position, to the evenings spent at the association. Those who have watched, as we have watched, the society from its beginning can point to many successful engineers that acknowledge its helpfulness to them. It has offered opportunities to individuals who availed themselves of them. A fruitful subject for deliberation at its annual conventions would be how to improve the efficiency of the organization as an uplift for the engineer as a class. Thanks to a resolution adopted at the Minneapolis convention last year, this will be done at the coming convention at Evansville. It is a most commendable move, certain of good for the association and the individual.

It Can't, It Can Be Done

IN ANY national, state or civic undertaking there are always those who tell us that it cannot be done, and who spend considerable time and energy to prove their contentions. But in spite of all the proof that the thing cannot be done, the wheels of progress move steadily onward; and that which we are told today is impossible of attainment, is done tomorrow. Government ownership of public utilities, we are told, is an impossibility, and volumes have been written to show that it is a failure; but one has only to turn his attention to what is being done in the Province of Ontario, Canada, to see that government-owned utilities can be a success.

As a result of the conference in June between the coal-mine operators, the Secretary of the Interior, Federal Trade Commissioner Fort, Chairman Peabody and the committee on coal production of the Council of National Defense, the coal operators agreed to reduce

their prices from the unheard average of approximately five dollars per ton to approximately three dollars per ton, with a further decrease of fifty cents per ton to the Government for all coal needed. Secretary of War Newton D. Baker and William B. Clover, of the Federal Trade Commission, objected to these prices agreed upon, as being excessive. It will be recalled that the operators only agreed to reduce their price after the Federal Trade Commission had warned them that Congress would act if they did not, also Pomerene's Senate Committee was sitting, at the time the agreement was made, to consider a law giving the Government the right to take over the coal mines and operate them. But when the Government objected to the operators' price and again threatened to take over control of the mines, the oft-repeated impossibility of Government ownership argument was put forward by the coal-mining interests.

They tell us: "The coal operators were eager for some public action which would help them to reduce their prices under control, that the operators wanted to act jointly and bring prices down themselves, but could not for fear of the law." The mystifying part of this assertion is that the coal operators doubled and trebled their prices without any apparent fear of the law, but when it came to a reduction all became fearful of the consequences of the law. Does this not look like a fear of losing exorbitant profits, and not of the law?

We were told: "It is physically impossible for any board, of any possible size, to control the mining and distribution of such a quick-moving commodity as coal. It is true," they say, "some board or bureau, ignorant of the size of the task, may consent to undertake such a thing. But in our opinion it would wreck itself and do irreparable injury to the industry and the consumers by its signal failure. We do not think it advisable to try any such experiment in such times as these."

The foregoing does not sound very rational in the light of what has been accomplished in European countries in the control of the coal industry. In England the Government took over complete control of the coal mines after less radical methods of regulation failed. The French Government has become the sole vender of the nation's coal supply. The Provisional Government of Russia has taken over the control of all coal mines of that country with the object of regulating the distribution and prices of coal. Almost at the very outbreak of the war, Germany took measures to centralize the control of its whole coal industry in the hands of its Government. In Italy all coal is imported and distributed by the Government. If government control of the coal industry is impossible, it is amazing to think that some of the European countries have not awakened to this fact and abandoned a practice that some of our well-meaning citizens tell us will surely end in disaster.

The provisions made in the food-control bill, giving President Wilson special authority for the administration of the coal resources of the country, and the recent exercising of that authority in materially reducing the price agreed to by the coal operators show that the President has no fear of disaster, at least when there are well-established precedents that government control of the coal industry has been a success in other countries. He is giving a deaf ear to those who are trying to tell him it can't be done.

New York Chimneys Smoke

IS NEW YORK CITY to become as bad as Pittsburgh used to be in its ability to saturate the atmosphere with smoke that belches from the chimneys of many of the hundreds of its power plants?

The scarcity of anthracite coal of the buckwheat size and its increased cost during the past year or so have caused many plants to turn from hard to soft coal; and as a result there are many smoke offenders of such violent character that a visit of a smoke inspector would result, if New York possessed an adequate smoke-prevention bureau.

Changing from hard to soft coal may mean to some merely switching the order to the coal dealer and that it is just as simple a matter to change from the one fuel to the other and burn it without smoke in the same furnace, without any alterations to conform to the new requirements.

A little thought should convince one that smokeless combustion cannot be obtained with soft coal in a boiler furnace that has been designed to burn hard coal, any more than one could expect to burn soft coal successfully on grates designed for burning shavings.

Steam users must get rid of the idea that any kind of furnace will burn soft coal without smoke. Of course, there are those who do not care one way or the other whether the tops of their chimneys resemble volcanos in eruption; and there are others who do not know how to prevent the smoke, but who would do so if they did.

A properly designed furnace will burn soft coal without smoke, if a competent fireman will properly handle the fires, and there are hundreds of them doing it. An investment in a suitable mechanical stoker will be a paying proposition if soft coal is to be burned in the future, and the indications are that Eastern cities will continue to use more of it than in past years.

Although pages upon pages have been devoted to the losses due to the furnace conditions that exist when a chimney is smoking, it would seem that the situation, in so far as the engineer is concerned, is something similar to the public school where each scholar must be taught the lessons—and some of them never learn them.

Dollars and cents count with the average individual and especially with the manufacturer. Many an engineer can testify that he has failed to obtain improvements or new equipment because he was unable to show that a saving would be made by the introduction of the apparatus. On the other hand, if it can be shown that money can be saved, the management will sometimes lend a listening ear.

The aggregate loss from a smoke ladened atmosphere in disfigurement of buildings, soiling of clothes, carpets and hangings, impairing of goods in stock, etc., warrants energetic measures for its prevention.

Correspondence

The Care of Turbine Oil

The article and editorial in the Aug. 7 issue of *Power* on the proper care of turbine oil are timely.

The more general use of steam turbines has brought up many new problems in power-plant operation, most of which have been successfully solved. However, it would seem that the proper treatment of turbine oil has been one of the last of these problems to be tackled, although progressive engineers have for some time made

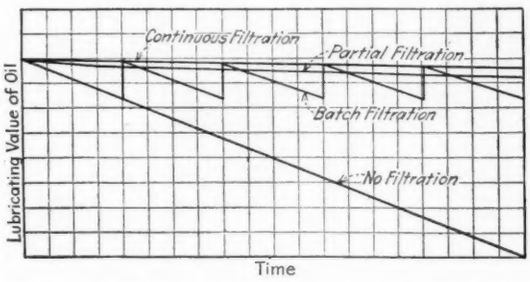


FIG. 1. SHOWING GRAPHICALLY THE RELATIVE ADVANTAGES OF FILTER SYSTEMS

attempts to give some treatment to the oil, even though many of these attempts were quite crude.

While there is some confusion in the article between saponification and emulsification, practically any chemist or engineer of any of the large lubricating-oil companies admits that, due to the severe conditions encountered in steam-turbine operation, oxidization takes place, forming products that in time become insoluble in the oil and settle, forming a muck. I have seen steam turbines that have been operated without any filter, in which the small settling tank has had 4 or 5 in. of this muck in the bottom. In some instances where the pump suction is taken from too near the bottom of the reservoir, this muck is forced around into the oiling system and has clogged up the sight feeds and the oil piping.

Many operating engineers do not seem to realize that, with most makes of steam turbines now on the market, water is bound to get into the lubricating oil. There is always more or less leakage of steam past the glands at the high-pressure end of the turbine. This steam condenses and settles in the base of the turbine and becomes mixed with the oil.

In our experience in dealing with steam-turbine filtration we employ three different systems for purifying the oil: (1) Continuous circulating and filtering systems in which all of the oil used on the bearings is passed continuously through a filter. Such systems can be used only on very small units. (2) Partial filtration system, in which a percentage of the dirtiest oil is continuously bled out of the bottom of the oil reservoir on the turbine, passed through a filter and returned again to the turbine. (3) Batch filtration, in which all of the oil contained in the turbine is removed and purified in a separate filter, the turbine being immediately filled with filtered oil from the last batch purified. This system requires two charges of oil, which are frequently interchanged.

The two latter systems only are of interest to the operator of a large plant. The relative advantages of these three systems can be compared graphically as shown in Fig. 1. This comparison shows that the system of partial filtration is the most practical, as it has very nearly as high an efficiency as continuous filtration. On the other hand, it requires a separate filter for each turbine, whereas with the batch system one filter would serve four or five turbines. Therefore, whether the partial or the batch system is employed depends upon the amount of money that can be spent for such a system and the ideas of the operating engineer.

As the system of partial filtration is rather new, the typical installation shown in Fig. 2 will probably prove interesting. Oil is continuously drawn off from the bottom of the oil reservoir, as at *A*, and allowed to flow by gravity to the filter. As the oil reservoir contains a body of oil that is fairly quiescent, water and muck

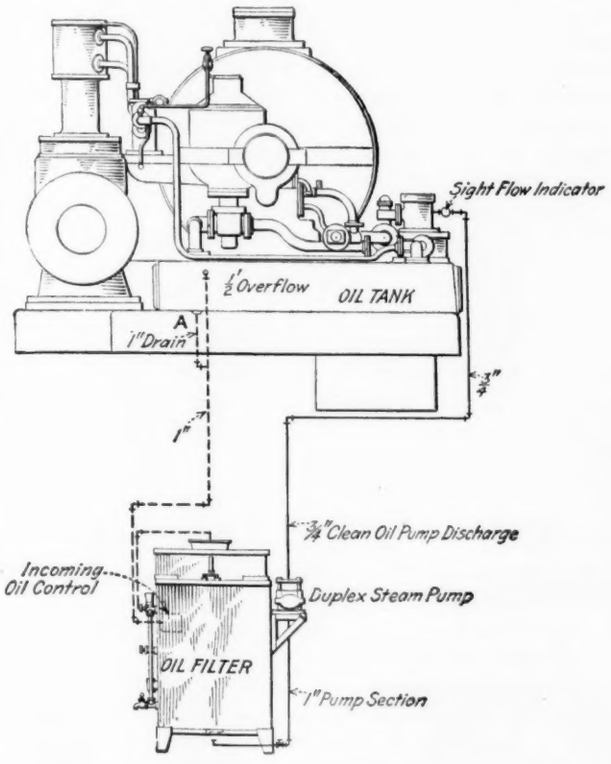


FIG. 2. FILTER AND CONNECTIONS TO TURBINE

settle to the bottom so that the muck, which one ordinarily finds in one of those reservoirs which is operated without a filter, is continuously drawn off and passed through the filter, where it is removed from the oil. A steam pump mounted on the filter returns the filtered oil back again to the turbine oiling system. An auto-

matic float-operated inlet valve eliminates any danger of the oil being drained off from the turbine.

Systems like the above have been in operation for over 2½ years and, as far as we can see, the oil is every bit as good as the day it was put into the turbine. The oil has never had to be removed entirely, it being necessary only to add a small amount of oil occasionally to make up for evaporation.

The amount of oil to be bled off in partial filtration depends very largely on local conditions—that is, the kind of oil used, the amount of water that finds its way into the oil, the temperature of the bearings and of the power plant, etc. However, for ordinary conditions we have found that by providing a filter of sufficient capacity so that it will filter all of the oil contained in the turbine at least once an hour satisfactory results are obtained; that is, with a 35,000-kw. turbine, which usually contains about 1000 gal. of oil, it is well to use a filter having a filtering capacity of 1000 gal. of oil per hour.

Cooling Turbine Oil

The proposition of cooling turbine oil is certainly one that needs further investigation, as hardly any turbines seem to be provided with sufficient cooling surface to keep the oil at a reasonable temperature. This may be due to the fact that engineers have used heat transmission coefficients similar to those employed in condenser and feed-water heater practice, which of course gives a quantity of surface entirely inadequate. Tests made at the United States Naval Experiment Station showed that the transmission coefficient, or the B.t.u., transferred per hour per square foot of surface per degree mean difference of temperature varied from 39 to 125, while tests made by Mr. Boella, of the Italian Corps of Naval Architects, showed transmission coefficients ranging from 33 to 180.

It would thus seem that successful steam-turbine lubrication requires the use of a suitable filter and the employment of larger or more efficient cooling coils than are now furnished.

In passing, it is well to note that, when partial filtration is employed, the filter can be equipped with cooling coils so that the oil bled out for filtration can be cooled continuously and thus help along the regular turbine cooler.

G. F. Fenno.

Milwaukee, Wis.

Turbines Fail To Carry Load

We are having quite a bit of trouble in our plant and I would like to have the opinions of practical engineers. We have two 750-kw. turbines, but neither will carry its full load. When first started up, they were all right, but since changing over a few times, all they will carry is from 400 to 450 kw. Above this they will slow down and the frequency drops, throwing the synchronous-motor-driven exciter out, which necessitates starting a steam-driven exciter to get the alternators back on the line. This has happened as often as fifteen times in one day, so now when the load gets up to 400 kw. the other turbine is started, which of course is wasteful.

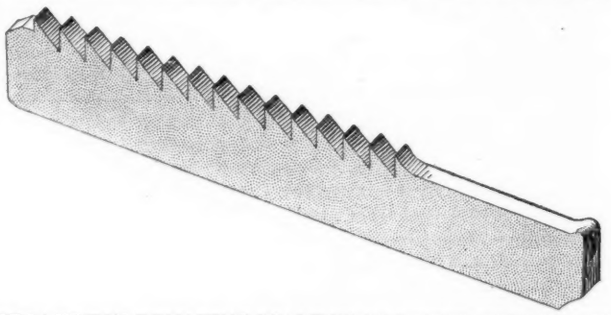
When synchronizing, a switch on the board is used, controlling a motor on the governor to speed up or slow down the machine until it is in step. I think the trouble is that when slowing the machine down to get it into step, more tension is put on to cut out some of the admission valves, and that it is never taken off, so that when the load comes on there is not enough steam admitted to hold up the speed. The trouble is not with the steam, as it is held at 175 lb. I would like to hear from some one who can help us to a solution of our difficulty.

F. R. Arnold.

Chicago, Ill.

Removing Scale Between Headers

I have tried the suggestion for removing the scale from between headers, offered by R. W. McLaren in the issue of Apr. 10, page 498, and while the thinner scale responded to the compass-saw treatment, the plan was a failure when the thick, stubborn scale was tackled.



BROACH FOR REMOVING SCALE FROM BETWEEN HEADERS

But since appealing for aid, I have hit upon a plan that answers pretty well, though not as expeditious or satisfactory as I would like. I made several special drills to use in an electrical drill to cut through the scale; then with thin flat broaches made from old files, as shown in the illustration, the scale is driven out. At best it is a long, rather discouraging and laborious job.

Concord, N. H. C. H. Willey.

Why Gasoline When Water Is Available?

The high cost of gasoline, as well as its present low quality, is responsible for the great influx on the market of substances and devices intended to supplement gasoline as an automobile-engine fuel or to combat its cost by increasing the mileage per gallon. These substances or appliances, having more or less merit, may be grouped roughly into three classes—gasoline substitutes, gasoline savers and gasoline improvers. Under the first class may be placed all liquid hydro-carbons intended to supplement gasoline; the second includes those contrivances and devices built to increase the air supply at certain engine speeds; and the third class is made up of those substances which are placed in the gasoline tank to increase the power of the mixture.

In Holland the gasoline condition is acute and there has recently sprung up a company which advertises a device not belonging to any of the classes named, but claiming the advantages of them all. It is based on the familiar principle of electrolysis, or the property of decomposing water into its two elements, hydrogen and oxygen, by passing a current of electricity through it—a dream that has kept many an ambitious inventor awake nights in the vain attempt to apply it to some practical commercial purpose.

Holland has been flooded with circulars descriptive of the apparatus, and as the promoters may extend their activities to this country, it will be well to warn the uninitiated, who might be tempted by the wonderful and unlimited possibilities it promises, that it is without merit. A translation of the circular follows. Special attention is called to the next to the last paragraph.

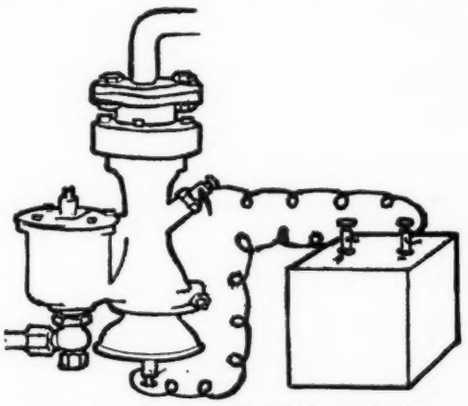


FIG. 1. REPRODUCED FROM CIRCULAR

For many years the human intellect has been occupied with the construction and the improving of the internal-combustion engine, more especially the gasoline engine.

The gasoline engine is the cause of the great progress made in automobiles, marine engines and airplane engines. It has also been the cause of reducing the fuel consumption, by making the combustion engine more capable of using cheap fuels. The first engines ran fairly well with high-grade gasoline of 0.68 specific gravity. Later on, experiments made it possible to use 0.75 specific gravity, followed by the use of benzol, petroleum, raw oil, naphtha, etc., fuels that cost only a few cents per kilogram.

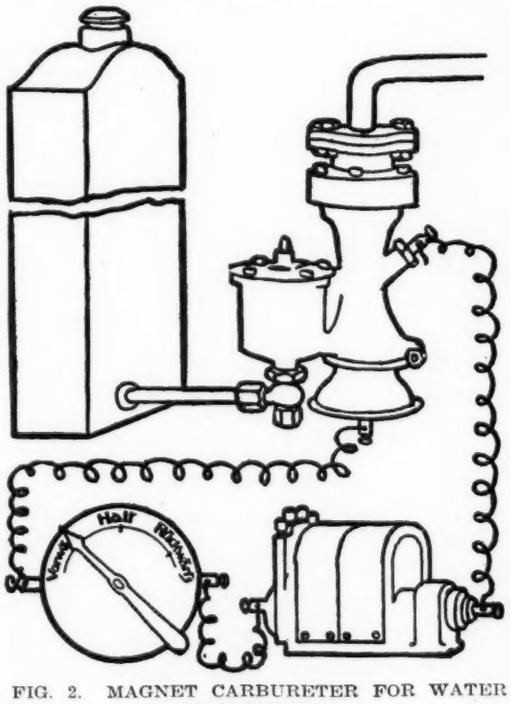


FIG. 2. MAGNET CARBURETER FOR WATER (REPRODUCTION)

In water we find a large quantity of hydrogen gas, the well-known gas which has a great fuel value. The new apparatus made according to the known system of G. A. Benzine Carburateurs, contains anodes that are able to separate water into hydrogen and oxygen by the use of an electric current. The hydrogen is then used in the same way by the well-known generator installations in the engine. At first, the required current was obtained by a storage battery (Fig. 1).

Then the use of a storage battery having ignition purposes was abolished and was replaced by a magneto. We found it necessary to bring into the market a form of carbureter known as the G. A. Magnetcarburateur for water (Fig. 2).

Besides the great reduction in the cost of fuel consumption, we find another advantage in the change of mechanism of the automobile or motor boat. The gasoline tank is not necessary. The carbureter is simply connected to the cooling system, as the use of warm water is of a great advantage in this process.

The great heat value of hydrogen gas increases the power of the engine, and the speed is especially fine. Therefore it is not necessary to have the different speed changes.

We have solved the question of reversing motion in a very simple and ingenious way. As you know, by the separation of water, hydrogen forms on the negative and oxygen on the positive electrode. Therefore, by reversing the direction of the current, the chemical action is also reversed, and also the motion of the engine, with the result of giving backward motion, which is especially of an advantage in motor boats.

The cost of running the storage batteries was very small, but by the use of the magnetcarbureter the cost is absolutely nothing, because the engine itself causes the necessary current. It is very easily attached to any motor boat, and we will be glad to give advice as to how to attach it in any special case. For further information, address

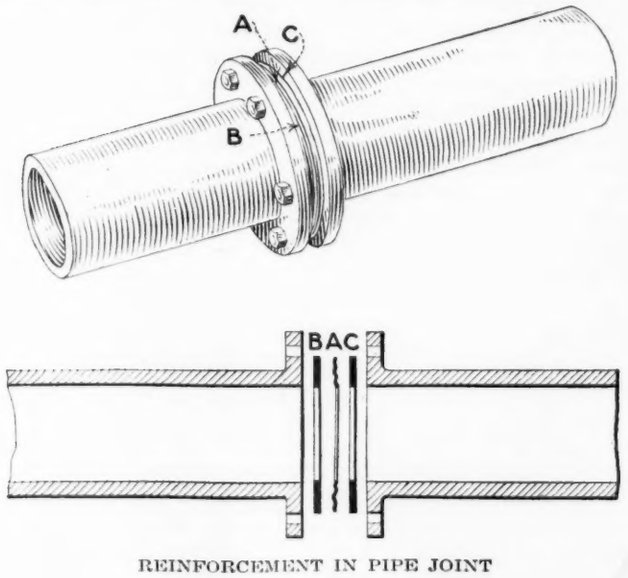
THE HOLLAND-AMERICAN CARBURATEUR COMPANY,
ACHTEROM-DEN-HAAG.

The foregoing seems to have aroused considerable curiosity, and one gentleman in Holland wrote me asking for further particulars. C. R. STROUSE.

Scranton, Penn.

Reinforcing Rubber Gaskets

An excellent joint for high pressure, especially when the flanges are rough and uneven, is made as shown in the illustration and consists of a corrugated copper gasket *A* and two sheets of rubber packing *B* and *C*. The copper gasket tends to strengthen the rubber against the pressure, and on rough flanges the rubber makes a joint that will stand severe tests. By this means, too, flanges that do not come quite square can be made to hold by using thick rubber or building up with extra sheets on the open side. Thin joints are usually preferable, however, where they can be used.



REINFORCEMENT IN PIPE JOINT

Brooklyn, N. Y. WILLIAM FORRAY.

"Who Would Be Liable?"

In connection with Mr. Andrew's question, "Who would be liable?" in the issue of July 24, page 130, I would like to say that I think as he does that the place for the engineer is in the engine room and not working at odd jobs around the place. That is one of the things wrong with engineering work today; some employers expect the engineer to do all kinds of other work. An engineer should be held responsible for the engine and boiler rooms and should do nothing else that will take him away from his engine room over five minutes at any time, and even this is dangerous unless there is an assistant to take his place while out.

Mr. Andrews asked what should be done if necessary repairs were reported to the owner and no attention was given the notice. I think if it was dangerous to run the plant, I would refuse to run it until it was made safe and would refuse to do anything foreign to my trade for anybody except in a case of great emergency.

FRANK WELLS.

Jeffersonville, Ind.

It is the engineer's duty to give to his employer the best of his ability and to do everything in his power to make the station a success. Every day is composed of 24 hours, and during that time he is on duty 12 hours and sometimes longer. If every engineer thought, "Well, this is not my job," and waited for the other fellow to come along and do it, the plant would soon run down and the engineer's reputation would be gone forever. The only way for an engineer to reach the top of the ladder is to do everything that he possibly can, whether it belongs to his end of the game or not. If things are not in a safe condition, it is the engineer's duty to put it up to his employers like a man. If they turn him down, he should go after them again and impress it on their minds and make them see the point. That seems to be the trouble with engineers; they haven't "spunk" enough to carry them through; they are too much afraid of being criticized.

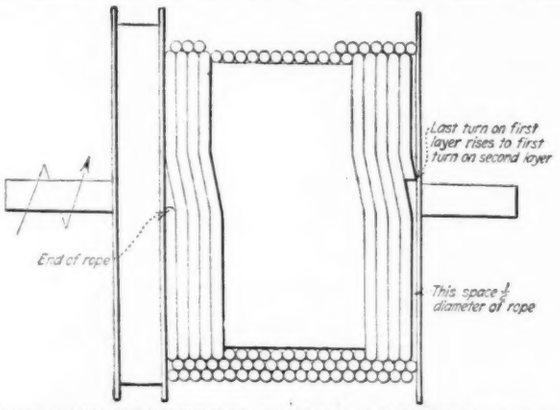
I have been engaged in engineering for 15 years and have been criticized, "cussed" and everything else, but that didn't bother me in the least, for I started out with the determination to "get there," and still have the same determination.

C. R. REYNOLDS.

Oklahoma, City, Okla.

How Is Rope Best Wound on Hoisting Drum?

I would like to see a discussion as to the best method of winding wire hoisting ropes on drums, especially where there are several layers. I have found it impossible to wind several layers of rope unless the first layer is put on with a sort of wave. I have tried to make this clear in the illustration. This method has the disadvantage that if the fleet angle is very large or if the drums are near the sheaves, the rope will chafe at each turn and where each turn crosses over the under turns. This wear can be distributed along the rope if a piece is cut off the drum end from time to time. On the other hand, if the rope is started so that it lies straight, and the open space between the end of drum and first turn is filled in with a tapered piece of hemp rope, as I believe is the usual practice, it will wind all right if but two layers are put on; but open spaces will develop at or near the corners of the drum and keep getting worse



ONE WAY OF WINDING CABLE ON HOISTING DRUM

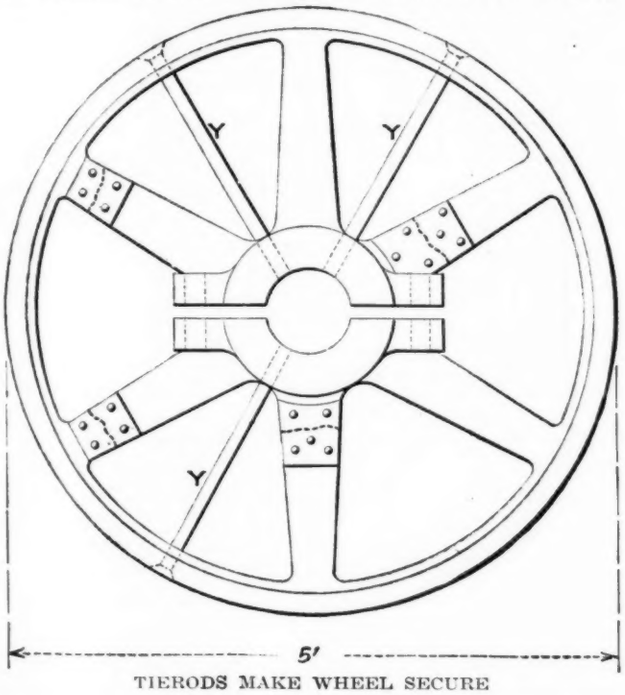
as more layers are added, and I have found that the wear to the rope due to its falling into these open spaces is more severe than the chafing from the method of winding described. There are many other interesting questions relating to hoisting ropes that I would like to have discussed.

CAESAR F. PEIRANO.

Melones, Calif.

A Pulley Repair Job

The illustration shows how I repaired a broken flywheel, 5 ft. in diameter and 12 in. face, four of the arms being cracked as indicated by the dotted lines. The special feature of the job is the draw rods *Y* used



TIERODS MAKE WHEEL SECURE

to draw the parts together before riveting the strap patches on. In fact, I consider the draw rods of more importance toward strengthening the wheel than the patches.

WILLIAM FORRAY.

Brooklyn, N. Y.

Inquiries of General Interest

Anhydrous Ammonia—What is the difference between ammonia liquor and anhydrous ammonia? J. R.

Pure ammonia (NH_3), according to the temperature and pressure, can exist in the condition of a gas, liquid or solid, and when unmixed with water it is called anhydrous ammonia. Anhydrous ammonia dissolves in water in different proportions, forming what is called ammonia water, ammonia liquor, aqua ammonia, etc.

Double Stop and Drain for Boiler in Battery—Why are two stop valves required on a boiler set in battery? T. L. M.

When two or more boilers are connected with the same steam header, each boiler should be provided with two stop valves and there should be an ample valved drain between such stop valves, to be opened to the atmosphere for relief of any leakage of steam back through the outer stop valve when the boiler is under inspection or out of use.

Steam Seal of Corliss Valve—What is the difference between steam seal and lap of the valves of a Corliss engine? R. C.

Steam seal in a Corliss valve is the amount a valve overlaps the edge of the port when the dashpot is at its lowest position. Lap is the amount the edge of the steam or exhaust valve lacks of being line on line with the edge of the steam or exhaust port when the wristplate is in its central position with the steam valves hooked up.

Advantages of Steel Over Cast-Iron Fittings—What is the advantage of a steel pipe flange over one made of cast iron? G. C.

Flanges and other pipe fittings made of steel are superior to those made of cast iron, because steel is stronger and tougher; and as the material has much greater ductility, steel fittings are safer from rupture by unequal expansion of the fitting or movement of the pipe to which the fitting is attached. Also, the fittings are much less likely to crack or break without warning.

Thickness Required for Boiler Shell—What should be the thickness of shell plates of 55,000 lb. tensile strength for a horizontal return-tubular boiler 66 in. diameter by 16 ft. long, with horizontal seams of 80 per cent. efficiency, to carry a working pressure of 150 lb. per sq.in. with a factor of safety of 5? P. J. K.

$$\textit{The thickness} = \frac{\textit{radius} \times \textit{pressure} \times \textit{factor of safety}}{\textit{tensile strength} \times \textit{efficiency}};$$

hence the required thickness would be,

$$\frac{30 \times 140 \times 5}{55{,}000 \times 0.80} = 0.477, \textit{ or about } \frac{15}{32} \textit{ in.}$$

Position of Crank When Keying Up Connecting-Rod—What is the best position for placing an engine when keying up the connecting-rod brasses to take up lost motion? R. W.

The keying should be done with the crank in such a position that tightening the brasses will cause them to clamp the diameters of the pins that have been least reduced by wear. The part of the crosshead and crankpins least affected by wear depends on the steam distribution and length of the connecting-rod, but for practical purposes, sufficient allowance for difference in wear is obtained for keying up the brasses when the crank is placed on a dead center.

Obtaining More Compression on Corliss Engine—Cannot compression of the exhaust on a single-eccentric Corliss engine be increased by lengthening the exhaust-valve rods? W. L. K.

Simply lengthening the exhaust-valve rods would obtain more compression by causing the exhaust valves to close earlier, but it also would make release later. If more compression is desired, it should be obtained by advancing the eccentric and make both compression and release earlier. By thus advancing the eccentric, all events occur earlier in the stroke, and if it results in excessive lead then more lap must be given to the steam admission valves by lengthening the steam-valve rod arms to cause the steam valves to open later.

Height of Suction Lift—Why cannot a pump raise water by suction through the height of a column of the water that would balance the pressure of the atmosphere? R. E. A.

Because part of the pressure of the atmosphere is required to overcome the pressure of air or vapor that is incompletely removed by action of the pump plunger, the pressure of air and vapor liberated out of the water on account of a reduction of its pressure, and the pressure required for overcoming frictional resistance to the passage of the water through the foot valve, suction pipe and fittings and water passages to the pump chamber.

Steam Discharged by Safety Valve—What is Napier's rule for discharge of steam from a safety valve? W. T. L.

Napier's formula for flow of steam from a safety-valve aperture or other orifice where discharge is made into a pressure that is less than 58 per cent. of the initial pressure is:

$$W = \frac{A \times P}{70}$$

in which

W = Weight of steam discharged per second;
A = Area of aperture or opening through which the steam is discharged in square inches;
P = Initial pressure of the steam, pounds pressure per square inch absolute.

Alternating-Current Feeder Cables Heating—In our plant, a five-story building, a 300,000 cir.-mil power feeder cable runs in a 3-in. conduit from the switchboard in the basement to the top floor, about 143 ft. one way. The average capacity of the motors installed on each floor is 43 hp., or a total of 215 hp. Up to the second floor the cable heats seriously. What is the cause of this heating? The average load is only about 275 amp. on a 225-volt, 60-cycle, two-phase circuit. W. S.

The statement that the average load is only 275 amp. would be inexplicit in conveying an idea of the actual load conditions under which the cables are operating. With 215 hp. of motors on a 220-volt, two-phase circuit, the current in the outside conductors is 484 amp. and in the center conductor 684 amp. With only an average of 275 amp. in the outside legs, the average in the center leg is 386 amp. This will seriously overload the center cable. The Board of Fire Underwriters' rating is only 275 amp. for a 300,000-cir.mil rubber-covered cable. Therefore it is evident that the cables up to the second floor are overloaded. The best plan would be to install a separate cable to take care of the load on the first and second floors and not increase the size of the conductors already installed.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Interpretations by the Boiler Code Committee

Interpretations of the Boiler Code Committee, as approved by the Council on June 21, 1917, in Cases Nos. 150, 153-157 and 159-161 inclusive, are given. As in previous reports, the names of inquirers have been omitted. Proposed changes in the Code are also given.

THE Boiler Code Committee of the American Society of Mechanical Engineers meets monthly for the purpose of considering communications relative to the Boiler Code. Following are some recent interpretations of the committee. Copies of the Boiler Code may be purchased from the society, 29 West 39th St., New York City. For nonmembers the cost is 80c. per copy; for members, 40 cents.

CASE NO. 150 (REOPENED)—Inquiry: Is it permissible under the rules of the Boiler Code to brace that portion of the head of a horizontal return-tubular boiler below the tubes with diagonal braces, or must this portion of a boiler be braced with through stays?

Reply: Diagonal bracing is not permissible for that portion of the front head of a horizontal return-tubular boiler which comes below the tubes, under Par. 218 of the Code, but it is permissible for the corresponding portion of the rear head.

CASE NO. 153—Inquiry: Does the crowfoot brace illustrated in Fig. 7 meet with the requirements of Par. 223 and Table 4 of the Boiler Code?

Reply: The strength of each branch of the crowfoot in the design shown is difficult to compute. As the crowfeet vary

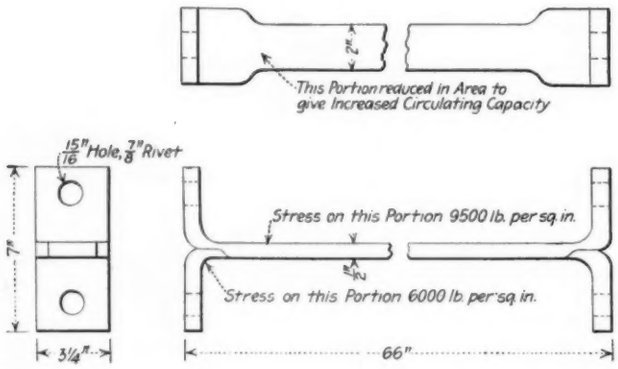

This Portion reduced in Area to give Increased Circulating Capacity
15/16" Hole, 7/8" Rivet
7"
Stress on this Portion 9500 lb. per sq. in.
Stress on this Portion 6000 lb. per sq. in.
3¼"
66"

FIG. 7, CASE 153. PROPOSED SIDE BRACE FOR 150 LB. W. P.

so widely on different braces, it was the idea of the Boiler Code Committee in formulating this rule that the manufacturer would test each type of brace made to determine whether it meets the requirements or not, and the committee suggests that the braces be tested to determine the relative strength of the body of the brace and of a crowfoot. According to the rule, the foot of the brace should be one-third stronger than the body of the brace. It, therefore, follows that if a test brace is made with the body one-third stronger than the brace to be used, the crowfoot of this test brace should be as strong as the body of the brace.

CASE NO. 154—Inquiry: In the staying of a segment of a head, above the tubes, of a horizontal return-tubular boiler in which a manhole is inserted, is there an allowance of 100 sq.in. under the rules of the Boiler Code, as is allowed by Par. 218 for manholes inserted in heads below the tubes?

Reply: Where a manhole is placed above the tubes in a horizontal return-tubular boiler, and allowance shall be made as for the head surface that need not be braced, and the bracing of the head with such manhole opening should conform to that which would be used provided there was no manhole.

CASE NO. 155—Inquiry: What is the application of the rules in Part I, Section 2, of the Boiler Code to the workmanship on steel-plate heating boilers? Are punched rivet holes permissible, and also may cast-iron mud rings and door-frame rings be used?

Reply: The Code does not require the drilling of rivet holes for boilers for low-pressure heating or hot-water supply, except those that come under the power boiler rules as specified in Par. 335. This also applies for cast-iron mud rings and door-frame rings, where used.

CASE NO. 156—Inquiry: (a) Will brass or bronze valves and fittings with flange ends in accord with the "1914 Brass Standard Flange Dimensions," when bolted to ferrous fittings as prescribed in Code Tables 15 and 16, comply with the purpose and intent of the Boiler Code Committee's reply in Case No. 101? (b) Does the Boiler Code Committee approve the recommendation that the raised face be removed from a Table 16 fitting when it is bolted to a brass or bronze fitting? (c) Does the Boiler Code Committee approve the recommendation that full-face gaskets be used in a nonferrous to nonferrous or a nonferrous to ferrous flange joint?

Reply: (a) The standardization of bronze fittings has been referred to a special committee of the society. Until a report upon such standards is prepared and accepted by the society, the Boiler Code Committee will abide by the decision in Case No. 101. (b) All dimensions shall conform to the American Standard given in Tables 15 and 16 of the Appendix for the pressures therein specified, except that the face of the fitting to which it is attached shall be flat and without the raised face where brass or bronze com

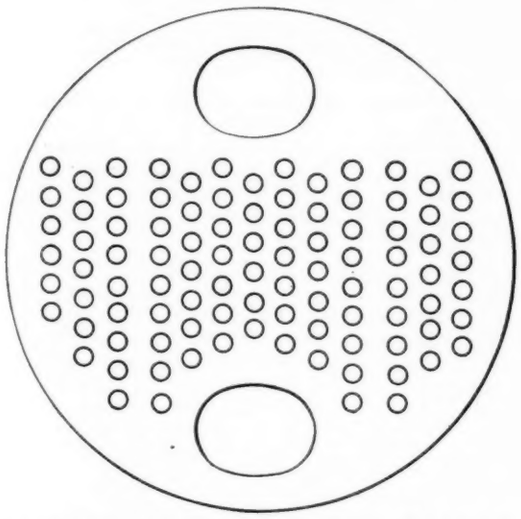


FIG. 8, CASE 161. HEXAGONAL ARRANGEMENT OF TUBES IN H.R.T. BOILER

position fittings are used. (c) It is the opinion of the committee that full-face gaskets should be used.

CASE NO. 157—Inquiry: (a) Will cast-iron dovetail lugs be permissible under Par. 323 and 324 of the Boiler Code? (b) In empire and economic type boilers, where the pads on the cross braces form a reinforcement to the side sheets, what coefficient should be used under Par. 199 of the Boiler Code? (c) A ruling is desired covering Par. 254 of the Boiler Code, if no burrs are present.

Reply: (a) This inquiry is answered by Case No. 151. (b) According to Par. 203, the value of C to be used should be 135. (c) It is the opinion of the Boiler Code Committee that the plates should be separated to make sure there are no burrs.

CASE NO. 159—Inquiry: If the material of which a dished head is formed is thicker than necessary under the rules of the Boiler Code to sustain the pressure carried, is it

necessary to flange a manhole opening, if inserted, to a depth of three times the thickness of the material used?

Reply: The intent of Par. 198 of the Code is that a manhole opening in a dished head shall be flanged to a depth of not less than three times the required thickness of the head, measured from the outside. If, therefore, the required thickness of material for a head is ½ in., the opening needs to be flanged to a depth of not less than 1½ inches.

CASE No. 160—Inquiry: Does Par. 316 of the Boiler Code allow the feed inlet to be located 3 in. from the bottom tube sheet of a small, vertical laundry boiler?

Reply: The committee has decided that the requirement of Par. 316 does not apply to a small laundry boiler of the type described.

CASE No. 161—Inquiry: Does Par. 218 of the Boiler Code prohibit the hexagonal or beehive arrangement of tubes used in the design of horizontal return-tubular boiler shown in Fig. 8? The reply in Case No. 142 is taken to apply to the usual tube layout, and does not seem to apply to the special tube layout there shown.

Reply: The reply in Case No. 142 applies irrespective of the tube arrangement in a horizontal return-tubular boiler.

REVISION OF BOILER CODE

The following proposed changes in the Boiler Code embody suggestions made at the meetings held at the society headquarters, Dec. 8 and 9, 1916, which were widely advertised as public meetings to which all those interested were invited to attend and participate in the discussions. Publishing the proposed changes will make it possible for anyone to discuss the revisions before they are brought to the final form and presented to the council of the society for approval. All suggestions will be gratefully received and will be carefully considered by the entire committee, and a full and free discussion is solicited.

Page 12, Par. 29a. Change to read as follows: Modifications in Elongation. (a) For material over ⅛ in. in thickness, a deduction shall be made from the percentage of elongation in Par. 28a of four times the thickness in inches in excess of ⅛ in. to a minimum of 20 per cent.

Par. 30a. Change to read as follows: Tension-test specimens shall be taken longitudinally from the bottom of the finished rolled material, and bend-test specimens shall be taken transversely from the middle of the top of the finished rolled material. The longitudinal-test specimen shall be taken in the direction of the longitudinal axis of the ingot, and the transverse-test specimen at right angles to that axis.[1]

Par. 30b. Change to read as follows: The test specimen shall bend cold through 180 deg. without cracking on the outside of the bent portion, as follows: For material 1 in. or under in thickness, around a pin the diameter of which is equal to the thickness of the specimen; and for material over 1 in. in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.

Page 13, Par. 33a. Change to read as follows: Number of Tests. One tension and one bend test shall be made from each plate as rolled.

Page 81, Par. 335. Change heading, which now reads "Boiler Materials," to "General."

A NEW SIZE OF BOILER STAMP

CASE No. 139—Inquiry: Is it possible to secure a smaller A.S.M.E. boiler stamp than the present ¾-in. stamp that is furnished to meet the requirements of Par. 332 of the Boiler Code? It is difficult to stamp thin plates with the present ¾-in. stamp on account of the rebound.

Reply: A new stamp will be provided, ½-in. size, hammer type, and with the top end square, so that it can be either used as a hammer stamp or struck with a sledge.

The Boiler Code Committee desires to announce that a new stamp is now offered in the form of a hammer stamp, with the size of emblem reduced to ½ in. The reduced size of the emblem will greatly facilitate the stamping of thin plates, and where desired the impression may be obtained by using the stamp as a hammer instead of as a sledge in the usual manner.

Manufacturers desiring stamps are reminded that applications either for new or old size stamps must be accompanied by an affidavit made out on the form provided by the Committee and properly executed according to the following resolution approved by the Council:

"It is the opinion of the committee that the official symbol or stamp is to be used to indicate that the American Society of Mechanical Engineers' rules have been complied with in the construction of the boiler. The stamp shall be affixed by the manufacturer. Certification to be governed by law or contract."

The blank affidavit form may be obtained upon application to the Boiler Code Committee at the society headquarters.

[1] Exceptions made for tension-test specimens for plate which is rolled longitudinally with reference to position when used in a boiler shell. See Par. 190.

Accident Problem of Electric Companies*

BY B. FRANK DAY
Philadelphia Electric Co., Philadelphia, Penn.

The accident problem of the electric power company is in most points identical with that encountered by practically all large employers of labor and has only such differences as are looked for in different industries where the type of machinery and operating method is obviously not the same as the plant that is producing for the use of the public an output of quite different character.

Our problems are only such as we know can be solved by the application of careful, common-sense methods, which means using good judgment in installing mechanical safeguards to all hazards and in securing the intelligent help of all employees, by educating them to an appreciation of the importance of personal caution in the performance of all work.

ELECTRICAL PLANT HAZARDS ARE FEW

Every industry has some few hazards, however, that are peculiar to itself, and the generating and distributing of electrical energy is not an exception. However, the hazards of the electric power company are in no sense so great as is generally imagined by those unfamiliar with conditions. The best-known methods of placing and of protecting apparatus or wires cannot be perfect, and for that reason the electric company has always urged both workmen and the public to consider all wires as dangerous and to avoid contact with such wires, unless properly insulated against grounds.

The accident problems of the electric company may be considered under three general divisions: Those that concern the safeguarding of men and equipment, those that concern the educating of employees and those that concern the safeguarding and the educating of the public.

The first of these problems confronts us at the generating station. Here the one ever-present thought in the mind of the construction engineer is safety, and maintaining it involves unceasing, vigilant effort.

Accident problems present themselves with the arrival and handling of the first material that enters into the construction of the building, or with the arrival of the first excavating equipment; and during the construction of the plant, safety is kept in mind from foundations to roof, as well as in designing and erecting all station equipment. The problem of safeguarding the workmen during construction is taken care of by having special inspectors who appreciate the need of every contractor using safe methods for the protection of his own men as well as the employees of all other contractors who must come and go amidst the varied and simultaneous operations. Throughout the progress of construction, "Safety Always" is being urged and practiced.

*From monthly bulletin Pennsylvania Department of Labor and Industry. Presented at the fourth annual Welfare and Efficiency Conference.

The modern use of high-voltage currents has resulted in the placing of the station conductors and live equipment in concrete compartments always inaccessible except to those employees who are specially trained and fully familiar with the care of such equipment. Remote control is the general practice in high-voltage stations, and only through the grossest lack of caution on the part of the employee could he come in contact with dangerous current.

The generally existing impression regarding the electric current and the danger of contact is an exaggerated one, and the fact of the matter is that where workmen use the proper precautions, in the way of dry shoes, rubber mats, line shields or dry wooden floors, they can work in perfect safety. The electric companies do their utmost to encourage the fullest use of all protective devices by wiremen and linemen, all of which are furnished freely to the workmen, and all such tools or devices as show indication of deterioration are renewed freely upon the return of the old equipment.

Throughout the station the importance of the accident problem is kept in mind and hazards minimized. Stairs are substituted for ladders wherever possible. Handrails and guards are placed about the generators and transforming equipment. Caution signs are prominently and permanently placed at all points where the thoughtless might trespass.

Human Element the Problem

Notwithstanding all efforts to prevent accidents, it is only too well realized that we are dealing with the human element—and with a certain number of men who will not save themselves from themselves. In beginning the construction of a large electric power plant on the Delaware River, arrangements have been made for the installation of a fully equipped temporary first-aid station and the regular attendance of a competent physician to give prompt attention to the many minor injuries, such as cuts, bruises and other injuries, that inevitably occur where a large number of men are engaged on an extensive construction job. This equipment is virtually a complete six-bed hospital, and after doing its good service during the construction period will be transferred to permanent first-aid quarters in the completed station. This indicates a practical solution of the prevention of infections and removes all excuse for neglecting minor injuries. One of our most annoying problems is the tendency of employees to conceal minor injuries and to apply home remedies that in many cases produce alarmingly dangerous conditions, sometimes jeopardizing the employee's life. It seems almost impossible to guard against this condition, which crops out every now and again, in spite of the fact that the employee thus penalizes himself through the disobedience of positive instructions. The company also maintains adequate first-aid cabinets at each station and office, and each construction wagon is also supplied with a cabinet which is fitted with all necessary supplies to care for the minor injuries that are of frequent occurrence.

The second accident problem of the electric company is that of educating employees, in the operating and distribution system, to a full appreciation of the nature and responsibility of the work and of the necessity for mental alertness and the application of common sense in the performance of the daily routine.

The fact of the latent danger is apt to be lost sight of, and the compliance with safety regulations is likely to become lax, if the campaign of educational safety work is not vigorously followed up; and at times it becomes necessary to penalize the careless man, even to the point of dismissal, when he persistently jeopardizes his own and his fellow-employees' safety.

Much can be done if the proper care is exercised in the selection of men for the various positions of responsibility according to the duties to be performed; and a man of known intemperate habits cannot be tolerated around the power plant.

Statistics indicate that the solution of the accident problem is at least 80 per cent. education in personal caution, and it would be useless to expend large sums of money for safeguarding devices and continuing safety organizations and not devote much time and system to getting the men to appreciate that their own well-being is the point of great importance, and that this result can be attained—not by safety devices so much as by their personal effort—by a mind that first thinks how to do the work safely and then performs the task.

The use of simple and positive rules has much to do with the prevention of accidents, and the rules laid down should be rigorously enforced. This is particularly true in regard to certain lines of work. It is often difficult to persuade men of the necessity of using safeguards, inasmuch as they are constantly working amid charged lines and seem to be satisfied to work on the theory that, not having had serious accidents, they are therefore immune.

Rules regarding the use of line shields, rubber gloves and safety belts are surprisingly distasteful to many linemen, but their use should be insisted on by all foremen, under penalty of dismissal.

Accidents to Lamp Trimmers

The lamp trimmers of our company had many accidents due to falls. The company insisted upon the use of a safety belt by all trimmers, and the result, during the first year, was a reduction of 60 per cent. in accidents to trimmers. There has not been a fatality among the trimmers for over two years, and it has become apparent that many fatalities of former years were in reality due to results of the fall from the pole, rather than to electric shock.

The old-time argument that the employer was only trying to get the men to save some money for him is about dead, and men now realize that the employer desires to save them to their families and to society, and jointly they are doing valiantly in minimizing the accidents in the electrical industry. The results of safety education of former years are manifest, and employees in all departments are helping to protect themselves and in most cases are heeding the injunction, "In case of doubt, adopt the safe course."

The third accident problem, that of safeguarding and educating the public to the careful handling of electrical wires and appliances, is one of some difficulty in the solution. Electrical accidents occur, not in the use so much as in the misuse of current or devices, and the very few authenticated instances of even minor injury among the vast number of persons using or working about electrical devices is a fair substantiation for the claim that the public generally appreciates the importance of a proper use of all equipment.

The very complete rules of the various underwriters' boards insure protection to the seller of, and the user of, electric current; and when to this inspection are added the still more exacting requirements of the electric company, it would seem that there is ample protection for the public and that fire or other accident can result only when rules are evaded, or when equipment is misused and no attention is given to repairing the defects.

Work of the Philadelphia Electric Co.

The Philadelphia Electric Co. furnishes electric service to the homes and industries of an area of three to four hundred square miles, and work on the facilities for distributing electric energy must be done during the busy hours of daylight. Poles must be erected and wires must be strung, and notwithstanding the confusion of traffic, accidents in connection with the performance of this work are rare. This is due to the fair measure of success we have had in solving this problem of accident prevention while performing the work and is the result of company rules, safety education and the fine spirit of coöperation on the part of the employees in carrying on the company work with a maximum of safety and a minimum of annoyance to the public.

We have intimated that good work is accomplished through the safety organization which covers all of our departments. It is through these committees that practically all accident problems of the company are worked out. Our plan is neither new nor cumbersome; it is simply effective, and is briefly as follows:

1. A Central Safety Committee of 13 department heads.
2. Department Committees of six men in every department of service.

3. Literature to Department Committees outlining the importance of the work and the importance of their active interest and the necessity of reports to the Central Committee.

4. Cards identifying members to their fellow-employees are issued to members of the Department Committee.

5. Safety-first buttons to everyone, and of a quality worth wearing.

6. Fobs to all Department Committeemen, bearing title "Safety League" and the employee's name. With the fob each member receives a letter bespeaking his continued active work in accident prevention and in training all other employees in safety methods. This retains their active support when their term on committee has ended.

The problems of our company have never been how to compensate accidents, but rather how to minimize or eliminate them, considering the subject purely from the humanitarian viewpoint; but realizing, as everyone must, that the immediate complete elimination of accidents cannot be accomplished, due to mechanical frailties as well as to the human element of the miscellaneous divisions of a large electric company, it has always been our practice to pay liberally to a fund from which injured employees received full pay. The passage of the Compensation Act of 1915 necessarily modified our method of compensating for disability due to accident, and the company is of course following the strict letter of the law.

The Compensation Act has been so admirably worked out in its details of administration and with such a spirit of fairness that it has not added any great burden on the electrical company that it does not willingly assume toward its many employees.

Book Review

THE ECONOMICAL PURCHASE AND USE OF COAL FOR HEATING HOMES. University of Illinois Circular No. 4, July, 1917. Published by the University of Illinois, Urbana, Ill. Paper; 6 x 9 in.; 53 pages; 22 illustrations. Price, 10c.

This is a nontechnical manual for the householder and operator of small house-heating plants, but contains much information of value to anyone in any way concerned with the proper use of fuel. This bulletin, which is of the sort frequently published by the Engineering Experiment Station of the university, gives the results of investigations by the station's staff. It deals with the requirements to be met by a satisfactory house-heating installation, characteristics of fuel, the purchase of coal, the operation of small heaters, factors affecting heat losses and a summary of installation and operating requirements.

In our issue of Aug. 14, page 238, appeared a review of "Practical Marine Engineering," by W. F. Durand. The review was of the fourth edition of this well-known book, so useful to the operating marine engineer. Through a misunderstanding the price of the book was stated as $4, whereas the book sells for $6. We regret the inconvenience which may have been caused to the publishers, "Marine Engineering."

Personals

O. H. Hutchings, associate general manager and engineer of the Dayton Power and Light Co., was recently elected president of the Ohio Electric Light Association.

Francis L. O'Bryan, electrical engineer of the Boston & Worcester Street Ry., has joined the purchasing department of the Edison Electric Illuminating Co., of Boston, Mass.

George A. Wardlaw, formerly with the American Institute of Electrical Engineers and editor of the "Electrical Record," has succeeded Paul B. Findley as editor of the "Electrical Age."

J. R. Murphy, for six years manager of the Great Bend (Kan.) Water and Light Co. and the Hoisington branch of the same company, has resigned. He will be succeeded by E. A. Wright, of Manhattan, Kan.

Stacy C. Richmond, of New York City, has been elected president of the Niagara Falls Power Co., the Niagara Junction Ry. Co. and the Niagara Development Co., to fill the vacancy made by Edward A. Wickes, resigned.

J. N. Helpbringer, for the last six years power-plant engineer with the Firestone Tire and Rubber Co., at Akron, Ohio, has resigned to accept the position of superintendent of power plants with the Kansas Gas and Electric Co., Wichita, Kan.

J. F. Usener, formerly chief engineer of power stations for the Houston (Tex.) Electric Co., has been appointed chief engineer of the Galveston-Houston Electric Ry., succeeding Charles Learmouth, who has become chief engineer of plants at El Paso.

Business Items

The Vacuum Ash and Soot Removing Corporation, located at 2 Rector St., New York, announces that it is now prepared to furnish complete suction ash- and soot-removing systems in which excessive wear and noise have been eliminated. Full description sent upon request.

Obituary

Arthur Kneisel, national treasurer for the American Association of Engineers, died in Chicago, Aug. 17. He was one of the original promoters of the association and was secretary up to this year. As a writer of technical articles, he always stood for the principle of elevating the engineering profession and receiving recognition for the engineer. He was born in Lexington, Ky., in 1880, and received his early education in the Lexington schools, later graduating from the University of Kentucky. He came to Chicago over 15 years ago and was engaged as a telephone engineer and patent attorney. At the time of his death, he was president of the Utilities Development and Sales Co.

Miscellaneous News

The Claremont (N. H.) Power Co.'s new 44,000-volt transmission line from Charlestown to Claremont is now in operation and giving the company capacity for its rapidly increasing load.

The Erie R.R. Co. is planning to build its own lighting plant at Marion, Ohio, with a view to illuminating its extensive yards there, which is a triple division point, and to insure the safety of its employees on night duty.

The Wilkes-Barre (Penn.) Light Co., after a fight lasting four years, has been awarded the contract for all of the city lighting. The contract is for five years, and it is estimated that the city will save $50,000 on its lighting bill during this period. The old company had been in control here for years.

The Metropolitan-Edison Co., by mergers recently approved, has acquired the properties of the Metropolitan Electric Co., the Edison Electric Illuminating Co. at Lebanon, Penn., and the Lebanon Valley Electric Light Co. (which operates in Myerstown, Penn.) The new company will have a controlling interest in the Pennsylvania Utilities Co., of Easton, which furnishes light, power and gas in Easton, Phillipsburg, N. J., and adjacent territory, serving a population of about 300,000. The Metropolitan-Edison Co. in turn will be controlled by the Reading Transit & Light Co., through ownership of its common stock.

The Reading Transit and Light Co., as a result of mergers recently approved by the Public Service Commission of Pennsylvania, at Harrisburg, has come into the ownership of properties that supply electricity for power and lighting in Reading, Lebanon and adjacent territory, and also becomes the owner of virtually the entire street-car system of Reading and its suburbs, heretofore operated under leaseholds. In addition to this the company will continue to lease and operate the Lebanon street-railway system and the links in the chain of other street railways extending from Reading through Norristown to Philadelphia, serving a population of about 350,000 with 200 miles of track. The mergers will make Reading one of the greatest electrical centers in the East. A 33,000-volt transmission line to connect the West Reading power plant with the Lebanon plant is being built at a cost of $60,000, and its early completion will mean one of the largest power services in eastern Pennsylvania. A number of big power systems will then be run together, and any of them will be able to use the surplus capacity of another in an emergency.

Engineering Affairs

The American Institute of Metals will hold a meeting at Boston, Mass., Sept. 24.

The International Union of Steam and Operating Engineers will hold a convention at Cleveland, Ohio, Sept. 10-15.

The American Electrochemical Society will hold a meeting at Pittsburgh, Penn., Oct. 3-6. There will be a session devoted to the application of electrochemistry and electric furnaces to the manufacture of war supplies and munitions. And an interesting address will be made by Alex Dow, president of the Detroit Edison Co., on "Production of Steam from Coal."

Four Combined Councils of the Universal Craftsmen Council of Engineers held a picnic on Sunday, Aug. 26, at Witzel's Park, College Point, N. Y. The beautiful day brought out an unusually large attendance. During the afternoon an entertainment was given in the main pavilion by Henry Frantzen, Joe McKenna, Monroe Silver, Frank Corbett, Billy Murray and Jack Armour. Dancing was the principal feature of amusement. Frank Martin was the winner of a handsome umbrella, the first prize in the bowling contest. The combination comprised Brooklyn Council No. 9, Melvin Council No. 9, Bronx Council No. 16 and Portable Council No. 49. The arrangement committee included Charles L. Knudson, William T. Jobson, E. T. Quade and H. G. Ohrtman.

The Association of Iron and Steel Electrical Engineers will hold its eleventh annual convention at the Bellevue-Stratford Hotel, Philadelphia, Penn., Sept. 10-14. A very interesting program has been arranged and the following papers will be presented: On Monday afternoon, "Safeguarding Electrical Equipment," by Walter Greenwood; "Heroult Electric Furnaces," by Walter C. Kennedy. On Tuesday forenoon, "Factors Relating to the Economical Generation and Use of Electric Power in the Steel Industry," by Brent Wiley; "Central-Station Power Supply to Iron and Steel Industry," by Joseph McKinley and Ray L. Baker. In the afternoon: "Electrical Reversing Blooming Mills," by Ralph D. Nye; "Electric Drives for Reversing Rolling Mills," by D. M. Petty. On Wednesday forenoon: "Fuel Economy by Coöperation in Establishing a Better Practice in the Operation of Stokers and Boilers," by Joseph G. Worker; "Turbo-Generators," by Richard H. Rice. In the afternoon: "Manufacture, Selection and Use of Carbon Brushes," by E. H. Martindale, followed by a patriotic meeting with talks by prominent Army and Navy engineers. In the evening the annual banquet will be held, to which ladies are especially invited. On Thursday forenoon and afternoon will be the standardization meeting under the auspices of the Standardization Committee of the association, at which motor, control and crane standardization will be discussed respectively by F. B. Crosby, T. E. Barnum and D. M. Petty, chairmen of the respective subcommittees. On Friday forenoon "Grab-Bucket Coal Hoists Operated by Alternating-Current Motors with Dynamic Braking and Regenerative Braking," by James Farrington and R. H. McLain; "Tool-Steel Gears and Pinions for Mill and Industrial Service," by E. S. Sawtelle. The afternoon will be devoted to inspection of plants of Cramp's Shipyard, Midvale Steel Co. and Baldwin Locomotive Works.

N. A. S. E. Special Train carrying the New York, New Jersey and Connecticut contingents will leave Weehawken, West Shore R.R., at 2.30 p.m., Sunday, Sept. 9. New England delegates will join them at Albany, 7.30 p.m., arriving Evansville, Ind., 5.30 p.m. Monday.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Sept. 1, 1917	One Year Ago	Sept. 1, 1917	One Year Ago
Buckwheat ..	$4.98—5.20	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.40—4.65	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	.....	.....	.....	.....
Barley	3.90—4.15	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Prices per gross ton for Boston delivery are as follows:

	F.o.b. Mines*		Alongside Boston†	
	Sept. 1, 1917	One Year Ago	Sept. 1, 1917	One Year Ago
Clearfields ...	$4.15—4.50	$1.15—1.75	$8.00—8.35	$4.25—5.00
Cambrias and Somersets...	4.40—4.75	1.45—1.90	8.25—8.50	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4.02—4.19, as compared with $2.85—2.90 a year ago; on cars Boston price is $9.00—9.25.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Ciroular[1]		Individual[1]	
	Sept. 1, 1917	One Year Ago	Sept. 1, 1917	One Year Ago
Buckwheat ..	$4.00—4.15	$2.75	$4.75—5.00	$2.40—2.75
Rice	3.40—3.60	2.25	3.00—3.50	2.10—2.20
Barley	2.90—3.10	1.75	2.25—2.50	1.85—1.95

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b.	Mine Prices
Bunker coal	$6.00—6.25	$4.00—4.50
Commercial	5.25—6.00*	3.00

*Based on Federal Trade Commission suggestion.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Sept. 1, 1917	One Year Ago	Sept. 1, 1917	One Year Ago
Buckwheat ...	$2.90	$1.65	$3.80	$2.55
Rice	2.40	1.00	3.40	.....
Boiler	2.20	.90	3.30	1.80
Barley	1.90	.75	2.15	....

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	Aug. 25, 1917	One Year Ago
Slack	$3.00—3.25	$0.95—1.00
Mine-run	3.00—3.25	1.35—1.45
¾-in.	3.50—3.75	1.45—1.55

Add 40c. per ton for freight charge to Pittsburgh.

Chicago—Current prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Saline and Harrisburg	West Virginia Smokeless	Springfield	Clinton and Sullivan Counties
Steam lump ..	$2.20	$2.20	$2.25	$2.20	$2.20
Lump	2.20	2.20	2.25	2.20	2.20
Egg	2.20	2.20	2.25	2.20	2.20
Nut	2.20	2.20	....	2.20	2.20
No. 1 nut....	2.20	2.20	....	2.20	2.20
No. 2 nut....	2.20	2.20	....	2.20	2.20
No. 3 nut....	2.20	2.20	....	....	....
No. 1 washed.	2.20	2.20	....	....	....
No. 2 washed.	2.20	2.20	....	....	....
Mine-run	1.95	1.95	2.00	1.95	1.95
Screenings	1.70	1.70	1.75	1.70	1.70

Hocking lump, $2.60; splint lump, $2.40.

Northern Illinois thin vein—Prepared sizes, $2.65; mine-run, $2.40; screenings, $2.15.

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Sept. 1, 1917	One Year Ago	Sept. 1, 1917	One Year Ago	Sept. 1, 1917	One Year Ago
6-in. lump..	$2.35	$1.35	.....*	$1.35	$2.35	$1.10
2-in. lump..	2.35	1.35	.....*	1.15	2.35	1.00
Steam egg...	2.35	1.35	.....*	1.15	2.35	1.00
Mine-run ...	1.95	1.15	.....*	1.10	1.95	.95
No. 1 nut..	2.35	1.35	.....*	1.25	2.25	1.10
2-in. screen.	1.85	.90	.....*	.90	1.85	.85
No. 5 washed	1.85	.75	.....*	.75	1.85	.75

*Strike.

Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Wash., D. C.—The Potomac Electric Power Co., 14th and C Sts., N. W., plans to build a power house on Benning Rd., N. E. Estimated cost, $40,000.

Ga., Atlanta—The Georgia Technical School plans to install a large power plant. Estimated cost, $30,000.

Kan., Parsons—The Kansas Gas and Electric Co., 237-9 South Main St., Wichita, plans to build a reducing station and switching tower on a site of land adjoining here. J. M. Strike, Engr.

Ky., Whitesboro—The Kentucky Power, Light and Saw Co. plans to build a steam-operated electric plant.

Miss., Greenwood—Yazoo & Mississippi Valley R.R. plans to build a 26 x 54-ft. brick power house. A. H. Egan, Memphis, Tenn., Gen. Supt.

Neb., Beaver Crossing—Village will receive bids until Sept. 6 for the installation of an electrical distributing system, including white cedar poles, copper wire, and transformers. R. A. Danskin, Clk.

Neb., Riverton—City plans a bond issue to install an electric-lighting plant.

N. H., Portsmouth—The Morely Button Co., Islington St., plans to construct a 1-story power plant in addition to its factory.

N. J., Bayonne—The Public Service Electric Co., 759 Broad St., Newark, plans to extend its conduit system and to improve the street-lighting system on lower Broad St. N. A. Carle, Newark, Ch. Engr.

N. J., Jamesburg—The Board of Managers of the State Home for Boys, plans to install power-plant equipment. F. H. Bent, State Capitol Bldg., Trenton, Arch.

N. J., Newark—The Murphy Varnish Co., Beecher St., will build a new boiler house in addition to its plant Estimated cost, $8000.

N. Y., Elmira—The Elmira Foundry Co., Main and Woodlawn Sts., plans to construct a 1-story, 40 x 40-ft. transformer station. Estimated cost, $10,000.

N. C., Southport—City having plans prepared for a power plant.

Ohio, Columbus—Erie R.R., 613 Euclid Ave., Cleveland, plans to install an electric-lighting plant.

Ohio, Salem—The Youngstown and Suburban Electric Line plans to construct a power house in place of the one at West Point.

Ont., Kirkland Lake—The Kirkland Lake Gold Mining Co. plans to build an electric substation and a concentrating mill.

Ont., Wallaceburg—City is having plans prepared by A. McNeice, City Engr., for a new brick hydro station. Estimated cost, $50,000. New transformers and general equipment will be required.

Penn., East Brady—The Rex Hide and Rubber Co. plans to build a power plant as an addition to its new factory. W. E. Moore Co., Union Bank Bldg., Pittsburg, Engr.

Penn., Harrisburg—City plans to install a light, heat and power plant.

Penn., Mount Carmel—The Edison Electric Illuminating Co., recently consolidated with the Pennsylvania Lighting Co., plans to extend its plant and system.

Penn., Philadelphia—The Dept. of Public Health and Charities will receive bids until Sept. 12 for the construction of a power house addition to the Philadelphia General Hospital, 34th and Pine Sts. P. H. Johnson, 1824-25 Land Title Bldg., Arch.

Penn., Philadelphia—The John Lang Paper Co., 24th and Vine Sts., plans to build a 1-story, 50 x 100-ft. boiler plant to its factory at 24th and Wood Sts.

Penn., Philadelphia—Thomas Potters Sons Co., 2nd St., plans to build an addition to its engine house.

Tenn., Columbia—The Columbia Water and Light Co. plans to rebuild its power station recently destroyed by fire; also install new generating equipment.

Tenn., Pulaski—The Pulaski Electric and Water Co., recently organized, plans to build an electric-power plant.

Utah, Salt Lake City—The Utah Power and Light Co., Kearns Bldg., plans to build a large steam-heating plant to cost several thousand dollars.

Va., Richmond—The Virginia Medical College plans to build a new 2-story power station. Nolan & Bakersville, Travellers Bldg., Arch.

Wash., Everett—The Washington Coast Utilities Co. has been granted a franchise by the County Commissioners and plans to build a 200-mile light and power line through 8 townships.

W. Va., Marlington—The Town Council plans to vote on a $20,000 bond issue. Part of proceeds will be used to install an electric-lighting plant.

Wis., Luxemburg—City will organize a company to build an electric-lighting plant.

Wis., Superior—The Great Northern Power Co., 15th Ave.,W., and Superior St., Duluth, Minn., plans to build a 13,000-volt transmission line. W. N. Ryerson, Duluth, Ch. Engr.

Prices—Materials and Supplies

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

ELECTRICAL SUPPLIES

KNIFE SWITCHES—Following are net prices each in cities named for knife switches mounted on slate base, front connected, punched clip type, 250 volts:

	30 Amp.	60 Amp.	100 Amp.	200 Amp.
D. P. S. T. fuseless	$0.52	$0.93	$1.90	$3.42
D. P. S. T. fused	.81	1.37	2.70	5.14
D. P. D. T. fuseless	.88	1.52	3.42	5.70
D. P. D. T. fused	1.67	2.58	5.62	9.88
T. P. S. T. fuseless	.78	1.40	2.86	5.14
T. P. S. T. fused	1.22	2.05	4.18	7.70
T. P. D. T. fuseless	1.37	2.35	5.24	8.82
T. P. D. T. fused	2.68	4.13	8.99	15.80

Lots $25 and more, list.

FUSES—Following are net prices of 250-volt inclosed fuses each, in standard packages, in cities named:

0-30 amperes	$0.11¼ each	110-200 amperes	$0.90 each
31-60 amperes	.15¾ each	225-400 amperes	1.62 each
61-100 amperes	.40 each		

FUSE PLUGS (MICA CAP) PER 100

0-30 amperes.. 4c. each in standard package quantities (500)
0.30 amperes.. 5c. each for less than standard package quantities (500)

SOCKETS, B. B. FINISH—Following are net prices in cents each in standard packages:

⅛-IN. OR PENDANT CAP			¾-IN. CAP		
Key	Keyless	Pull	Key	Keyless	Pull
22.10c.	21.00c.	42.00c.	27.30c.	26.20c.	46.20c.

Note—Less than standard package quantities, 15% off list.

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S. B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	....
T. P. S. B.	.81	1.80	....
D. P. D. B.	.78	2.10	....
T. P. D. B.	1.35	3.60	....
T. P. to D. P. D. B.	.90	2.52	....

ATTACHMENT PLUGS—Price each, in standard packages:

		Standard Package
Hubbell porcelain	$0.21	250
Hubbell composition	.12	50
Benjamin swivel	.12	...
Current taps	.35	50

FAN MOTORS—In quantities of 25 to 100, four-blade fans for alternating and direct current sell as follows:

	Non-Oscillating		Oscillating	
In. Diameter	60-Cycle A.C.	110-V. D.C.	60-Cycle A.C.	110-V. D.C.
9	$8.50	$8.00	$13.25	$11.00
12	12.80	11.50	16.50	14.75
16	15.75	13.50	19.00	17.15

Note—Complete with cord and plug.

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$25.00
No. 16 cotton twisted	36.00
No. 18 cotton parallel	30.00
No. 16 cotton parallel	44.00
No. 18 cotton reinforced heavy	39.00
No. 16 cotton reinforced heavy	53.00
No. 18 cotton reinforced light	35.00
No. 16 cotton reinforced light	47.00
No. 18 cotton Canvasite cord	32.00
No. 16 cotton Canvasite cord	38.00

LOOM—Price per 100 ft., in coils:

Ft. in Coil			Ft. in Coil	
¼ ... 250	$2.25	¾ ... 150		$7.00
⅜ ... 250	3.50	1 ... 100		10.00
½ ... 200	4.50	1¼ ... 100		12.00
⅝ ... 200	5.75	1½ ... 100		15.00

RUBBER-COVERED COPPER WIRE—Per 1000 ft.:

No.	Solid, Single Braid	Solid, Double Braid	Stranded, Double Braid	Duplex
14	$12.00	$15.00	....	$27.00
12	17.75	19.35	....	39.00
10	24.30	26.75	....	75.00
8	34.50	37.28	....	....
6	....	....	$64.85	....
5	....	....	76.75	....
4	....	....	92.64	....
3	....	....	112.00	....
2	....	....	135.75	....
1	....	....	175.00	....
0	....	....	267.00	....
00	....	....	330.00	....
000	....	....	405.00	....
0000	....	....	491.00	....

COPPER WIRE—Prices per 1000 ft. for rubber-covered wire in following cities:

	Denver			St. Louis			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$12.75	$17.25	$33.65	$14.00	$16.00	$28.00	$15.00	$18.80	$33.84
10	27.50	31.45	62.30	28.30	31.80	63.85	31.80	31.77	63.54
8	39.55	43.45	87.00	40.70	44.70	88.90	40.82	44.41	....
6	....	66.95	....	....	69.10	....	63.62	68.77	....
4	....	96.50	....	....	110.35	....	94.50	99.72	....
2	....	144.50	....	....	161.00	....	146.25	152.10	....
1	....	187.50	....	....	211.00	....	187.65	195.30	....
0	....	224.95	....	....	256.50	....	257.40	265.95	....
00	....	302.20	....	....	316.00	....	316.35	325.80	....
000	....	370.40	....	....	385.00	....	389.25	399.60	....
0000	....	425.25	....	....	469.50	....	475.20	486.90	....

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per unit for elbows and couplings:

	Conduit		Elbows		Couplings	
In.	Enameled	Galvanized	Enameled	Galvanized	Enameled	Galvanized
½	$69.70	$74.80	$0.1672	$0.1786	$0.0616	$0.0658
¾	92.00	98.90	.22	.235	.088	.094
1	136.00	146.20	.3256	.3478	.1144	.1222
1¼	184.00	197.80	.4185	.4496	.1581	.1698
1½	220.00	236.50	.558	.5994	.1953	.2098
2	296.00	318.20	1.023	1.10	.2604	.2797
2½	468.00	503.10	1.674	1.80	.372	.3996
3	612.00	657.90	4.464	4.79	.558	.5994
3½	763.60	818.80	9.86	10.59	.744	.7992
4	926.50	991.90	11.39	12.23	.93	.999

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

LOCKNUTS AND BUSHINGS—Following are net prices in standard packages, which are: ½-in., 1000; ¾- to 1¼ in., 100; 1½- to 2-in., 50:

	Locknuts Per 100	Bushings Per 100	Flexible Conduit Box Connections Per 100
½	$1.02	$1.68	$5.62
¾	1.75	4.00	7.12
1	3.00	6.15	10.50
1¼	5.00	8.20	15.00
1½	7.50	10.25	22.50
2	10.00	16.40	30.00
2½	12.30	24.60	67.50

ARMORED CABLES AND BOX CONNECTORS—Following are net prices per 1000 ft. cable and standard package of 100 box connectors in single and double strip:

	Twin Conductor		Three Conductor	
Wire Gage	Cable	Connectors	Cable	Connectors
14	$76.00	$4.50	$103.50	$4.50
12	101.25	4.50	127.50	4.50
10	138.75	4.75	176.25	4.75
8	176.20	5.75	247.50	6.00
6	277.50	6.25	362.40	7.50
4	431.25	7.50	....	....

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B— Watts	Plain	Frosted	No. in Package	Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.27	$0.30	100	75	$0.65	$0.70	..
15	.27	.30	100	100	1.00	1.05	24
25	.27	.30	100	300	3.00	3.10	24
40	.27	.30	100	500	4.50	4.65	12
50	.27	.30	100	750	6.00	6.25	8
60	.36	.40	100	1000	7.00	7.25	8

Standard package quantities are 10% from above prices. Yearly contracts ranging from $150 up allow a discount of 17% from list.

WIRING SUPPLIES—New York prices for tape and solder are as follows:

Friction tape, ½-lb. rolls	35c. per lb.
Rubber tape, ½-lb. rolls	45c. per lb.
Wire solder, 50-lb. spools	35c. per lb.
Soldering paste, 1-lb. cans	50c. per lb.

MISCELLANEOUS

HOSE—

	Fire 50-Ft. Lengths
Underwriters' 2½-in.	70c. per ft.
Common, 2½-in.	40-10%

	Air		
	First Grade	Second Grade	Third Grade
¾-in., per ft.	$0.55	$0.30	$0.25

Steam—Discounts from list

First grade... 30% Second grade... 30-5% Third grade... 40-10%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition ..... 50-10% Best grade 25%
Standard 40%

LEATHER BELTING—Present discounts from list in the following cities are as follows for cut lengths:

	Medium Grade	Heavy Grade
New York	40%	35%
St. Louis	45%	40%
Chicago	40—5%	35—10%
Birmingham	35%	35%
Denver	40%	45%

RAWHIDE LACING—40%.

PACKING—Below are prices each per pound in cities named:

		Asbestos			
		St. Louis	New York	Denver	Birmingham
Valve and Stuffing Box	Twisted plain, 25-lb. cartons	$1.25	$0.65@0.70	$1.40	$1.50
	Twisted graphite, 25-lb. cartons	1.25	.90	....	1.50
	Braided plain, 25-lb. cartons	1.50	.80	.60	1.50
	Braided graphite, 25-lb. cartons	1.50	1.00	.60	1.50

Asbestos wick in balls, ¼-, ½-, 1-, 25- and 50-lb. cartons, $0.65@0.70, New York; $1, Chicago.

Rubber asbestos, compressed sheets, medium grade about $0.80 in New York, 45c. in St. Louis, $1 Chicago.

Steam

Following in 25- and 50-lb. cartons:

	New York	Denver	Birmingham	St. Louis
First grade	$0.83	$1.00	$1.00	$0.80
Second grade	.55	.60	.90	....

Rubber and Duck

High grade	$0.50	....	....	$0.60
Cold water	.30	....	....	.40

Piston

Asbestos, duck and rubber	$1.75	$0.60	$0.90	$1.50
Flax, first grade	.94	.60	.60	.60
Rubber and duck	.90	.60	.32	.75

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard Thickness Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1-in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2-in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3-in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure ..... 15% off

Air cells for low-pressure heating and return lines { 4-ply .... 58% off; 3-ply .... 60% off; 2-ply .... 62% off }

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	New York	Denver	Chicago	Birmingham	St. Louis
Cup	5 to 7	8	7½	5½	5.6
Fiber or sponge	5 to 7	15	7¾	12½	5.9
Transmission	5 to 7	9	6¼	12½	5.9
Axle	3 to 7	5	5	4½	3.3
Gear	4 to 5	5	6½	10½	6
Car journal	5½ to 7¼	4½	6	9	3.75

WIPING CLOTHS—In Cleveland the jobbers' price per 1000 is as follows:

13¼ x 13¼ ..... $35.00 13¼ x 20½ $45.00

In Chicago they sell at $30@33 per 1000.

COTTON WASTE—The following prices are in cents per pound:

	New York			
	Aug. 29, 1917	One Year Ago	Cleveland	Chicago
White	11.00@12.00	12.50	16.00	14.00@15.00
Colored mixed	8.50@12.00	9.00	14.00	10.00@12.00

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Aug. 29, 1917	1 Year Ago	Aug. 29, 1917	1 Year Ago	Aug. 29, 1917	1 Year Ago
Raw in barrels	$1.26	$0.75	$1.30	$0.75	$1.27	$0.75
5-gal. cans	1.35	.85	1.40	.85	1.37	.85

WHITE AND RED LEAD in 500-lb. lots sell as follows in cents per pound:

	Red				White	
	Aug. 29, 1917		1 Year Ago		Aug. 29, 1917	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	13.25	13.50	10.50	11.00	13.00	10.50
25- and 50-lb. kegs	13.50	13.50	10.75	11.25	13.25	10.75
12½-lb. keg	13.75	14.00	11.00	11.50	13.50	11.00
1- to 5-lb. cans	15.25	15.50	12.50	12.50	15.50	12.50

AMMONIA—Below are prices per lb. in cities named:

	New York
26-deg. U.S.P. carboys of 100 lb.	13c.
26-deg. U.S.P. drums of 1000 lb.	12c.

Anhydrous ammonia in 100-lb. cylinders costs 30c. per lb. in St. Louis, Chicago and New York.

FIRE BRICK—Quotations on the different kinds in the cities named are as follows, f.o.b. works:

	New York	Chicago
Silica brick, per 1000	$50.00 to 55.00	$55.00 to 60.00
Fire clay brick, per 1000, No. 1	45.00 to 55.00	.....
Magnesite brick, per net ton	135.00 to 145.00	.....
Chrome brick, per net ton	135.00	.....
Deadburned magnesite brick, per net ton	85.00 to 90.00	.....
Special furnace chrome brick, per net ton	60.00 to 70.00	60.00 to 80.00

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—High grade, $55 to $65; St. Louis grade, $40 to $50.

Birmingham—Fire clay, $25 to $30; Denver, $23, per 1000.

FUEL OIL—Price variable, depending upon stock. New York quotations not available owing to this fact. In Chicago and St. Louis the following prices are quoted:

	Chicago	St. Louis
Domestic light, 22-26 Baumé	7¾c.	8.5c.

Note—There is practically no fuel oil in Chicago at present time.

OIL—Price per 50-gal. bbl. is as follows:

City	Fuel	Black	Red Engine	Steam Cylinder	Gasoline
Seattle	$4.45	$6.25	$11.00	$21.00	$10.25
Los Angeles	1.45	6.50	12.00	26.00	10.00
Denver	2.45	7.50	12.50	22.50	12.00
St. Paul	3.00	5.50	11.00	17.50	10.05
Cincinnati	5.00	5.50	10.50	17.00	12.00
Boston	5.25	8.00	12.50	18.75	12.50
Kansas City	6.95	4.35	10.35	17.35	10.15

Note—Standard prices of oil are necessarily difficult to give. Those above are for average grades.

POLES—Prices on Western red cedar poles:

	New York	Chicago	St. Louis	Denver
	72-82	52-62	52-62	33-42
6 in. by 30 ft.	$5.59	$4.94	$4.94	$4.32
7 in. by 30 ft.	7.40	6.60	6.60	5.80
7 in. by 35 ft.	10.70	9.60	9.60	8.55
8 in. by 35 ft.	12.20	10.90	10.90	9.65
7 in. by 40 ft.	12.35	11.00	11.00	9.75
8 in. by 40 ft.	13.75	12.15	12.15	10.65
8 in. by 45 ft.	18.20	16.20	16.20	14.30
8 in. by 50 ft.	21.85	19.45	19.45	17.15

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh; basing card of May 1, 1917, for steel pipe, of July 2 for iron pipe:

BUTT WELD					
	Steel			Iron	
Inches	Black	Galvanized	Inches	Black	Galvanized
⅛, ¼ and ⅜	42%	15½%	¾ to 1½	33%	17%
½	46%	31½%			

LAP WELD					
2	42%	29½%	2	26%	12%
2½ to 6	45%	32½%	2½ to 6	28%	15%

BUTT WELD. EXTRA STRONG PLAIN ENDS					
⅛, ¼ and ⅜	38%	20½%	¾ to 1½	33%	18%
½	43%	30½%			
¾ to 1½	47%	34½%			

LAP WELD. EXTRA STRONG PLAIN ENDS					
2	40%	28½%	2	27%	14%
2½ to 4	43%	31½%	2½ to 4	29%	17%
4½ to 6	42%	30½%	4½ to 6	28%	16%

Note—National Tube Co. quotes on basing card dated Apr. 1.

Stock discounts in cities named as as follows:

	New York		Cleveland	
	Black	Galvanized	Black	Galvanized
¾ to 3 in. steel butt welded	38%	22%	29%	15%
3½ to 6 in. steel lap welded	18%	List	36%	21%

	Chicago		St. Louis	
	Black	Galvanized	Black	Galvanized
¾ to 3 in. steel butt welded	38.8%	24.8%	34.27%	19.27%
3½ to 6 in. steel lap welded	42.8%	27.8%	27.27%	13.27%

Malleable fittings, Class B and C, from New York stock sell at list price. Cast iron, standard sizes, 15 and 5%.

BOILER TUBES—Discounts on less than carloads from Pittsburgh, freight to be added, effective from Nov. 1, 1916, on standard charcoal iron tubes, and from Apr. 2, 1917, on lap-welded steel tubes, are as follows:

Lap Welded Steel		Standard Charcoal Iron	
1¾ and 2 in.	31%	1½ in.	23%
2¼ in.	28%	1¾ and 2 in.	35%
2½ and 2¾ in.	34%	2¼ in.	32%
3 and 3¼ in.	34%	2½ and 2¾ in.	38%
3½ to 4½ in.	34%	3 and 3¼ in.	43%
5 and 6 in.	33%	3½ to 4½ in.	....
7 to 13 in.	30%	5 and 6 in.	37%
		7 to 13 in.	34%

Locomotive and steamship special charcoal grades bring higher prices; 1¾ in., over 18 ft. and not exceeding 22 ft., 10% net extra; 2 in. and larger, over 22 ft., 10% net extra.